ICF INTERNATIONAL

Final

Investigation of the CMSD Cap Failure and Specifications for Repair, Monitoring and Maintenance

Prepared for

Ormet Primary Aluminum Corporation
Hannibal, Ohio

7 March 2007

ICF International
33 Hayden Ave.
Lexington, MA 02421 USA

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ORMET
PRIMARY ALUMINUM CORPORATION

March 14, 2007

Mr. Bernie Schorle
Remedial Project Manager
SR-6J
USEPA Region V
77 West Jackson Blvd.
Chicago, IL 60604-3590

Dear Mr. Schorle:

Enclosed are two copies of the report summarizing the "Investigation of the CMSD Cap Failure and Specifications for Repair, Monitoring, and Maintenance" final document. The scope of work was developed by Ormet's engineering consultant ICF Consulting and modified by USEPA and OEPA comments.

If you have any questions please contact me at 740-483-2659.

Respectfully,

John Reggi
Director Corporate Env. Services

Enclosures

cc: Tommy Temple Ormet
Michael J. Sherron OEPASEDO (w/encl)

Hannibal Reduction Division
P.O. Box 176 / State Route 7
Hannibal, Ohio 43931
(740) 483-1381
(740) 483-2622 FAX

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1. Introduction

On or about 13 June 2006, field maintenance personnel detected a partial failure of the Ormet Primary Aluminum Corporation (Ormet) Construction Materials Scrap Dump (CMSD) landfill multilayer cap on the river (southern) side of the CMSD landfill. ICF inspected the failed areas of the cap on 19 June 2006. Based on the inspection and the review of construction documents, the multilayer cap consists of the following layers, listed from the top down:

- 2.0 to 2.4 ft. vegetative support layer (VSL)
- nonwoven geotextile filter fabric (Synthetic Industries Geotex 801)
- geonet drainage layer (Poly-Net PN3000)
- 40 mil textured HDPE geomembrane
- geocomposite clay layer (GCL) (Bentofix NS)

The field inspection indicates that the failure occurred along two interfaces: one between the geotextile and the geonet and one between the geonet and the geomembrane. The photos on the next page show the exposed geonet and geomembrane due to the movement along these two interfaces. The exposed geomembrane exhibited no evidence of rupture or distress from excessive strain. In addition to the areas of the cap which suffered total loss of the VSL, the areas to the east and the west of the failed zone had extensive cracking in the vegetative support layer and in some cases had displacements of up to three feet.

In this report, the factor of safety against failure along the interface between the VSL and the geotextile is first estimated by evaluating the discharge capacity of the geonet drainage system and analyzing the slope stability. The results indicate that the failure of the CMSD cap is due to inadequate slope drainage. The most likely sequence of events involved the development of positive pore pressures in the geonet, small displacements between the geotextile and the geonet, and the development of tension cracks in the VSL in the middle to upper part of the slope. Increased inflow of precipitation through the cracks into the geonet further exceeded the drainage capacity of the geonet and led to the development of greater positive pore pressures below the VSL. These pore pressures reduced the stability of the remaining portions of the cap in and below the cracked areas. Any standing water in the open cracks would have induced forces which further reduced the stability, albeit to a lesser extent.

Procedures for repairing the CMSD cap are also specified in this report and the attached specifications. The repair is designed to ensure that the geonet maintains sufficient discharge capacity and the VSL is effective in limiting the infiltration of precipitation into the geonet.

Monitoring and maintenance of the CMSD cap are important for its future stability. Installation of piezometer data loggers is recommended for monitoring pore pressure development within the geonet. The details of routine maintenance such as mowing the grass and visual inspection of the surface are also discussed in this report.

Photo 1: Exposed geonet due to slide along geotextile and geonet interface

Photo 2: Exposed geomembrane due to slide along geonet and geomembrane interface

2. Evaluation of Stability

2.1 Discharge Capacity of Geonet Drainage System

The geonet drainage system should be able to discharge the expected maximum flow into the drainage system from percolation, i.e.

$$q_c > q_m \tag{1}$$

where q_c = the discharge capacity of the geonet drainage system; and
q_m = the maximum flow into the drainage system from percolation.

USEPA (2004) recommends a minimum factor of safety (FS) of 2 for cases where the uncertainty in input parameters is low and the consequences of failure are small, i.e.

$$\mathrm{FS} = \frac{q_c}{q_m} > 2 \tag{2}$$

For many situations, a larger FS may be required. Koerner and Daniel (1997) have recommended using a FS value of at least 5 to 10 to account for uncertainties in the hydraulic conditions.

If the geonet drainage system has a slope angle β, the discharge capacity per unit width perpendicular to the direction of flow can be calculated by (see Figure 1)

$$q_c = T_{eff}\, i = T_{eff}\, (\sin\beta) \tag{3}$$

where T_{eff} = the effective transmissivity of the geonet drain; and
i = $\sin\beta$ = the hydraulic gradient.

T_{eff} can be estimated from the laboratory-measured transmissivity T_{lab} as follows (USEAP 2004):

$$T_{eff} = \frac{T_{lab}}{\mathrm{RF_{IN}RF_{CR}RF_{CC}RF_{BC}}} \tag{4}$$

where $\mathrm{RF_{IN}}$ is the reduction factor for elastic deformation and/or or intrusion of the adjacent geosynthetics into the drainage layer; $\mathrm{RF_{CR}}$ is the reduction factor for creep deformation of the drainage layer and/or creep deformation of adjacent materials into the drainage layer; $\mathrm{RF_{CC}}$ is the reduction factor for chemical clogging; and $\mathrm{RF_{BC}}$ is the reduction factor for biological clogging.

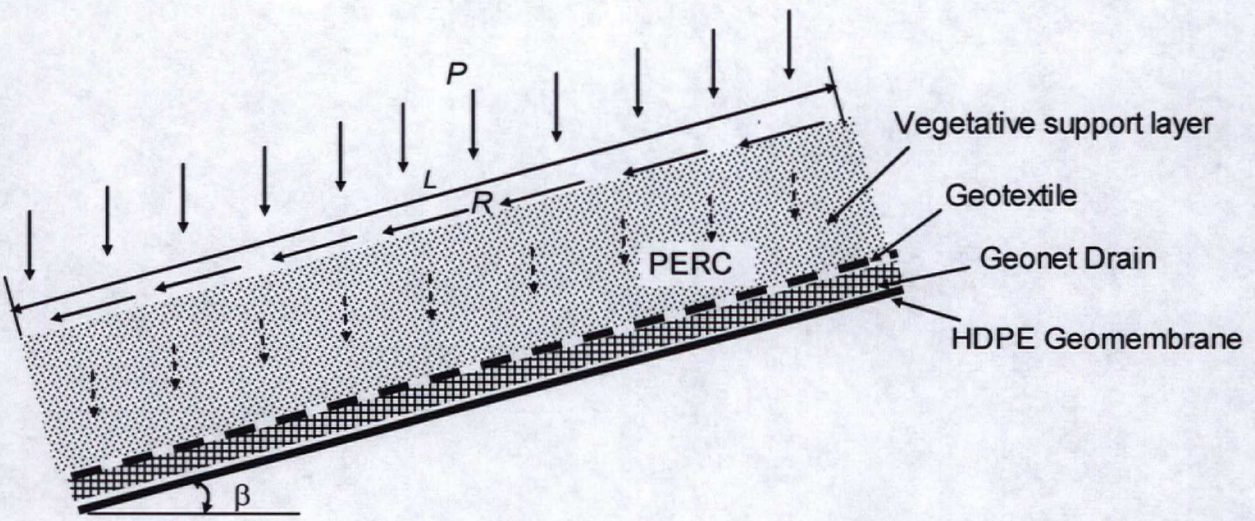


Figure 1. Geonet drainage system with slope length L and slope angle β.

For geonets used for surface water drains in landfill covers, the following reduction factor values can be used (Koerner 1998):

RF_{IN}	RF_{CR}	RF_{CC}	RF_{BC}
1.3 to 1.5	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5

For the geonet drain used at the Ormet landfill site, the laboratory-measured transmissivity T_{lab} is 1.00×10^{-3} m^2/sec (1.08×10^{-2} ft^2/sec) (National Seal Company). Using the average of each reduction factor, the effective transmissivity T_{eff} of the geonet drain can be estimated as 3.85×10^{-4} m^2/sec (4.14×10^{-3} ft^2/sec).

The maximum flow into the geonet drain can be determined by (see Figure 1):

$$q_m = \text{PERC} \times L \times (\cos\beta) \tag{5}$$

where L = the length of the landfill slope; and
PERC = the peak percolation rate.

Eq. (5) assumes no change in water storage in the cover soil and assumes that no water will percolate through the HDPE membrane.

Using the simplified manual method (Koerner and Daniel 1997; USEPA 2004), the peak percolation PERC can be estimated by

$$\text{PERC} = P - R = P(1 - C_r) \tag{6}$$

where P = the peak precipitation in the landfill area;
R = $P \times C_r$ = the runoff on the slope surface; and
C_r = the runoff coefficient depending on the surface soil type and the slope angle. For a 4:1 clayey soil slope, $C_r = 0.35$ can be selected (USEPA 2004).

According to the *Location and Design Manual, Volume 2: Drainage Design* by the Ohio Department of Transportation (2006), the Ormet landfill site is located in Intensity Zone D which has a peak hourly precipitation intensity of 2.46 in/hr at a return period of 25 years. The rain data from Climatic Data Center (NCDC) Cooperative (COOP) Station 333500 (Hannibal Lock and Dam) contains the daily rain amount and the rain period for each day. Using the COOP data between June 1998 (when the construction activities were substantially finished) and June 2006 (when the slide failure was noticed), the average rainfall intensities for heavy rain days[1] were estimated by dividing the daily rain amount by the rain duration.

On 2 June 2006, 1.46 inches of rain was recorded. Based on a storm duration of 9 hours, the average precipitation intensity was 0.162 in/hr. Because the COOP report indicates a period of heavy rain between 8:00 pm and 9:30 pm on 1 June 2006[2], we estimate that the maximum precipitation intensity during the storm was at least double the average precipitation intensity, i.e. at least 0.324 in/hr[3].

It is noted that peak percolation should not exceed the infiltration capacity controlled by the hydraulic conductivity of the cover soil, i.e.

$$\text{PERC} = P(1 - C_r) \quad \text{when } k_{cs} \geq P(1 - Cr) \tag{7a}$$

$$\text{PERC} = k_{cs} \quad \text{when } k_{cs} < P(1 - Cr) \tag{7b}$$

where k_{cs} = the hydraulic conductivity of the cover soil (VSL).

The hydraulic conductivity of the cover soil (VSL) was measured in the laboratory in January 2007 and found to equal 6.8×10^{-8} cm/sec. Studies have shown, however, that the effective hydraulic conductivity of a landfill cover is much higher than the value corresponding to the intact soil due to the effects of plant root penetration, insect and animal burrowing, freezing and thawing, and desiccation cracking.

[1] The set of "heavy rain days" includes the day in each month with the highest amount of precipitation, plus all days with an average precipitation intensity greater than or equal to 0.324 in/hr.
[2] The reporting period for the 2 June 2006 precipitation starts at 7:00 am on June 1st and ends at 7:00 am on June 2nd.
[3] The rainfall event of 2 June 2006 was not an extreme event. Based on reported precipitation amounts and durations, the maximum precipitation intensity between June 1998 and June 2006 was about 1.10 in/hr on 3 June 2000. In total, there were nineteen days since June 1998 when the average precipitation intensity exceeded 0.324 in/hr. Furthermore, the two week period prior to 2 June 2006 had little precipitation (0.64 in) and warm temperatures (4 consecutive days with highs between 85°F and 90°F), so the VSL would not have been saturated before June 2nd.

Typical hydraulic conductivity values of VSLs from 1.00×10^{-5} to 1.00×10^{-3} cm/sec (1.42×10^{-2} to 1.42 in/hr) (Richardson, et al, 2000) are used to evaluate the FS for the geonet drainage. The maximum infiltration rate is controlled by and increases with increasing hydraulic conductivity of the VSL, k_{cs}. Figure 2 shows the variation of the FS for the geonet drainage with variations in k_{cs}. The figure shows curves for the 25 year peak precipitation rate of 2.46 in/hr and for the peak precipitation rate recorded between June 1998 and June 2006, 1.10 in/hr. The FS for the geonet drainage decreases rapidly with increasing k_{cs}, reaches 1.0 when k_{cs} equals 1.22×10^{-4} cm/sec (1.74×10^{-1} in/hr), and continues to decrease as k_{cs} increases. At the peak recorded precipitation rate of 1.10 in/hr, the infiltration rate is limited by the hydraulic conductivity of the VSL soil unless k_{cs} is greater than 5.05×10^{-4} cm/sec (7.15×10^{-1} in/hr). At the 25 year precipitation rate of 2.46 in/hr, the FS for geonet drainage continues to decrease as k_{cs} increases.

If the hydraulic conductivity of the cover soil at the Ormet landfill site is greater than 1.22×10^{-4} cm/sec (1.74×10^{-1} in/hr), the geonet drain would not be able to discharge all of the rain water that infiltrates into it. The extra water will lead to a pore pressure rise below the VSL. If the pore pressure rises to a certain level, minor sliding may occur along the geotextile-geonet interface causing the formation of cracks in the cover soil (see the stability analysis in Section 2.2). The maximum pore pressure head that can be sustained at any location below the VSL without exceeding the weight of the VSL is (see Figure 5):

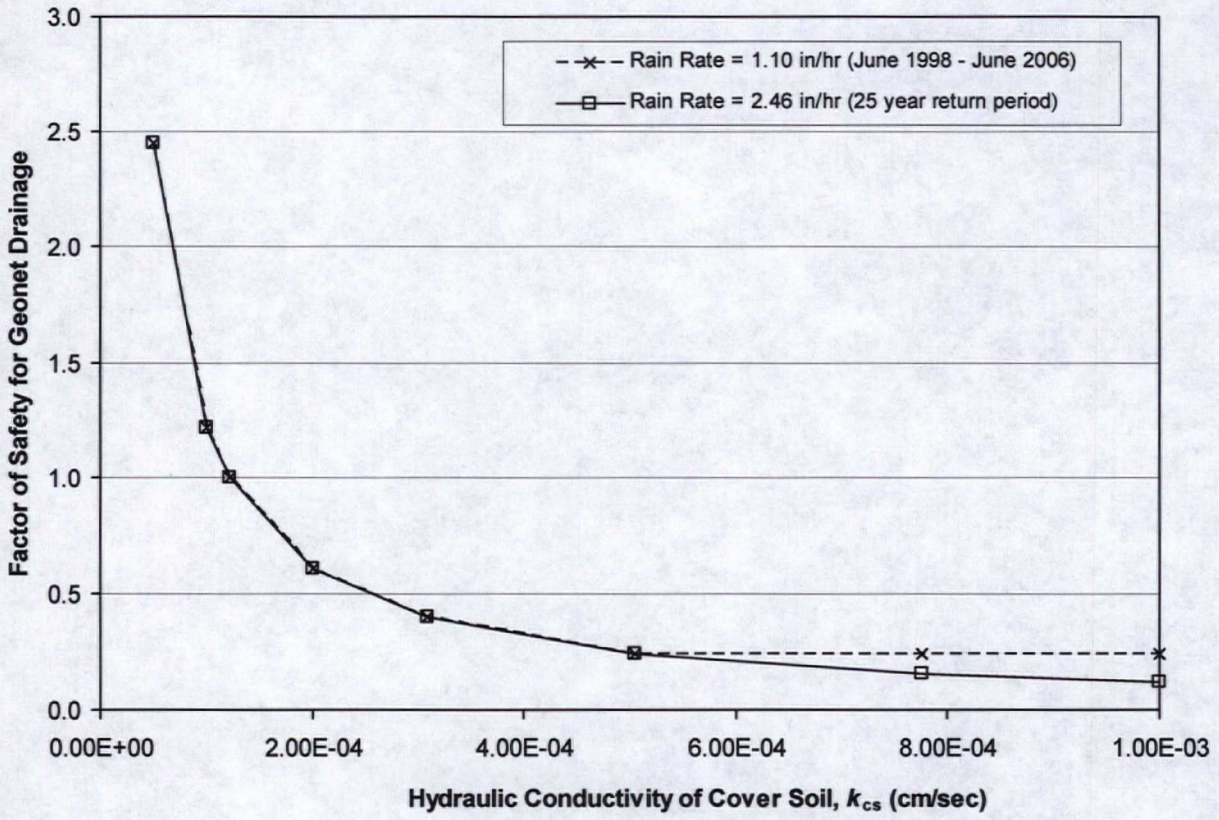


Figure 2. Factor of safety for geonet drain vs. hydraulic conductivity of VSL

$$H_{wm} = \frac{\gamma_t Z}{\gamma_w} = \frac{\gamma_t (t/\cos\beta)}{\gamma_w} = \frac{122.4\,pcf\,(2.0\,ft/\cos 14.04)}{62.4\,pcf} = 4.04\,ft \quad (8)$$

where H_{wm} = the pore pressure head at the location below the VSL;
γ_t = the total unit weight of the VSL;
Z = the thickness of the VSL in the vertical direction;
γ_w = the unit weight of water;
t = the thickness of the VSL; and
β = the slope angle.

If there are cracks in the cover soil (see Figure 3), all of the runoff in the area above the lowest crack will flow into the geonet drain. The combined runoff and percolation equal the precipitation over the area above the lowest crack. The maximum flow into the geonet drain can then be determined by:

$$q_m = [\text{PERC} \times L_c + (L - L_c) \times P]\cos\beta \quad (9)$$

where L_c = the length of the slope from the toe to the lowest crack (see Figure 3).

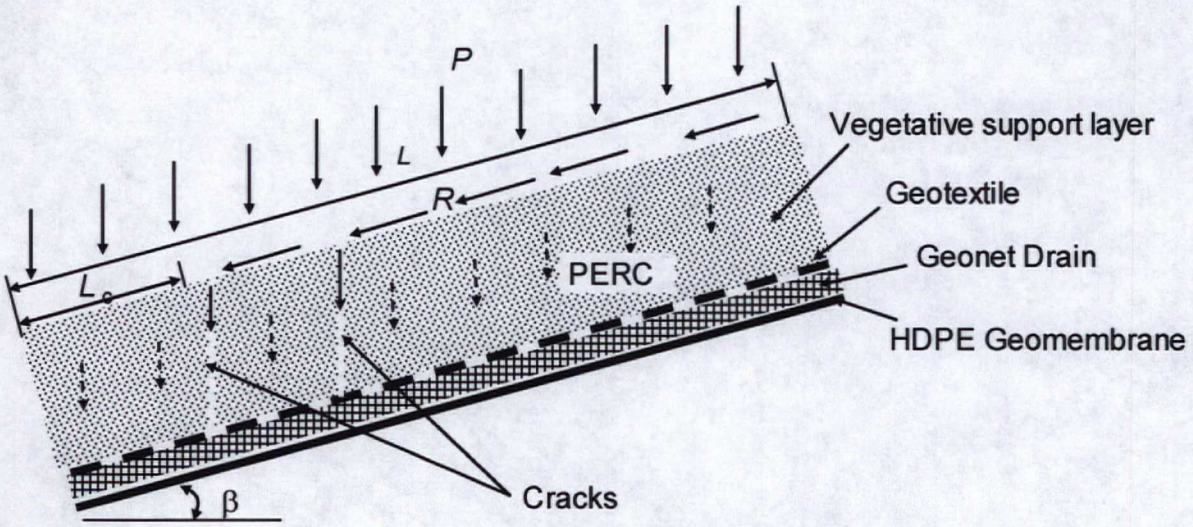


Figure 3. Geonet drainage system with slope length L, slope angle β, and cracks in the cover soil

Figure 4 shows the factor of safety for the geonet drain with cracks in the cover soil. Because all of the rain water on the slope above the lowest crack (at about 50 ft from the slope toe) will flow into the geonet drain, the FS for the geonet drain is much lower than that with no cracks in the cover soil (see Figure 2). With the cracks in the cover soil, the FS is smaller than 1.0 even at the rain rate of 0.324 in/hr on June 2, 2006.

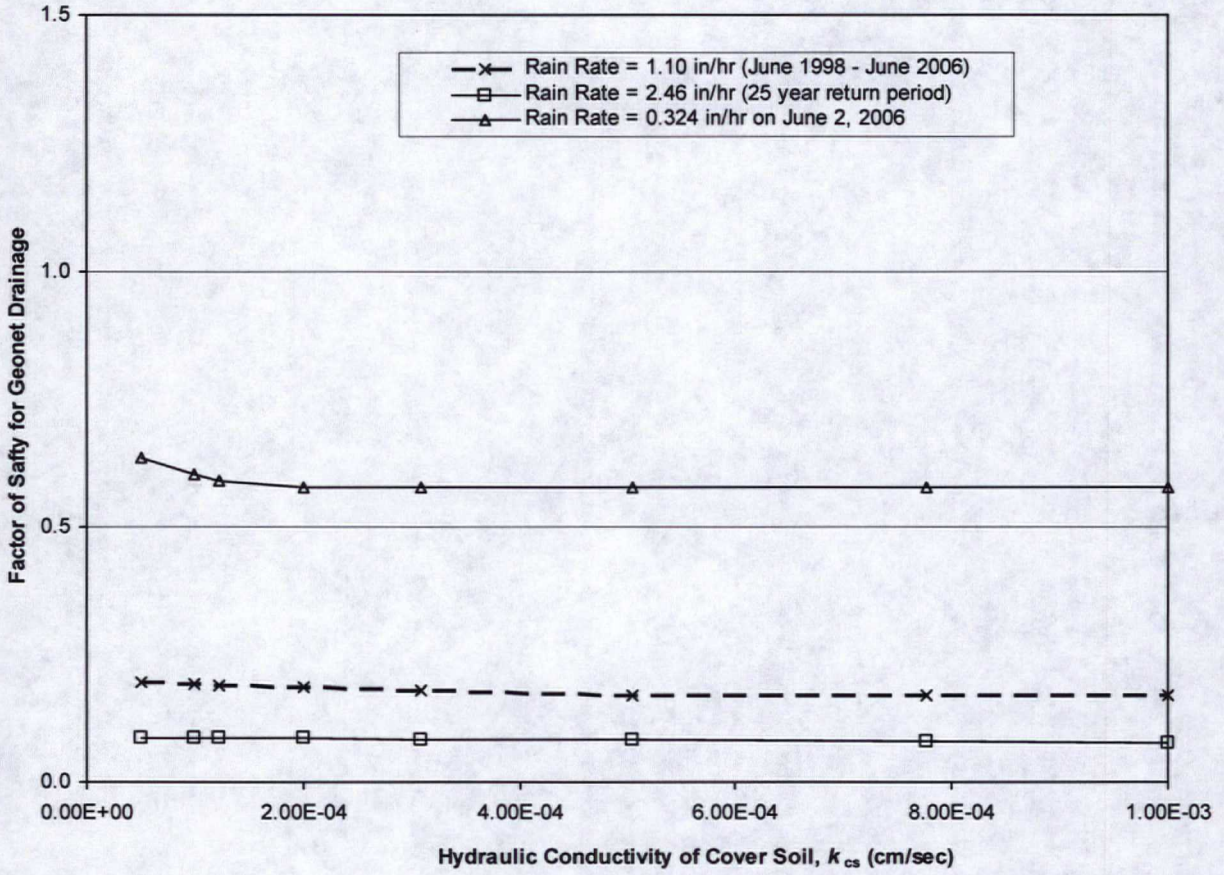


Figure 4. Factor of safety for geonet drain vs. hydraulic conductivity of VSL with cracks

2.2 Simplified Slope Stability Analysis – Infinite Slope

For a first check of the stability of the landfill slope, the slope is assumed to be infinitely long and the factor of safety against failure can be determined by (see Figure 5)

$$FS = \frac{c + [\gamma_t Z - \gamma_w H_w]\cos^2\beta \tan\phi}{\gamma Z \cos\beta \sin\beta} \qquad (10)$$

where FS = the factor of safety against failure;
c = the cohesion along the potential sliding interface;
ϕ = the interface friction angle of the potential sliding interface;
γ_t = the total unit weight of the VSL;
Z = the thickness of the VSL in the vertical direction;
γ_w = the unit weight of water;
H_w = the pore pressure head at the location below the VSL; and
β = the slope angle.

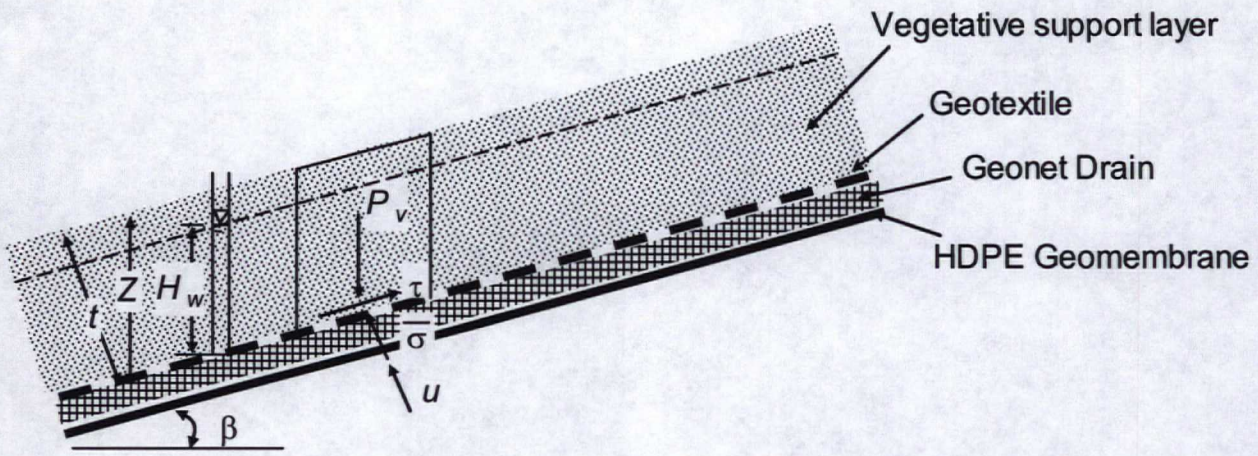


Figure 5. An infinite slope with pore pressure head above the potential sliding surface

When the geonet drain is not able to discharge all of the rain water flow into it, the excess pore pressure head H_w at a location below the crack can be obtained by solving the following equilibrium equation

$$T_{eff}\frac{d(H_w + x\sin\beta)}{dx} = \text{PERC}(L-x)\cos\beta + R(L-L_c)\cos\beta \qquad (10)$$

with the boundary condition $H_w = 0$ at x = 0 (see Figure 6).

$$H_w = \frac{\text{PERC}}{T_{eff}}(Lx - \frac{x^2}{2})\cos\beta + \frac{R}{T_{eff}}(L-L_c)x\cos\beta - x\sin\beta \qquad \text{at } x \le L_c \qquad (11)$$

where T_{eff} = the effective transmissivity of the geonet drain;
L = the total length of the slope;
L_c = the length of the slope from the toe to the crack;
β = the slope angle;
PERC = the percolation through the cover soil; and
R = the runoff on the slope surface.

The excess pore pressure head H_w at a location above the crack can be obtained in a similar way as

$$H_w = \frac{\text{PERC}}{T_{eff}}(Lx - \frac{x^2}{2})\cos\beta + \frac{R}{T_{eff}}(L-L_c)L_c\cos\beta - x\sin\beta \qquad \text{at } x > L_c \qquad (12)$$

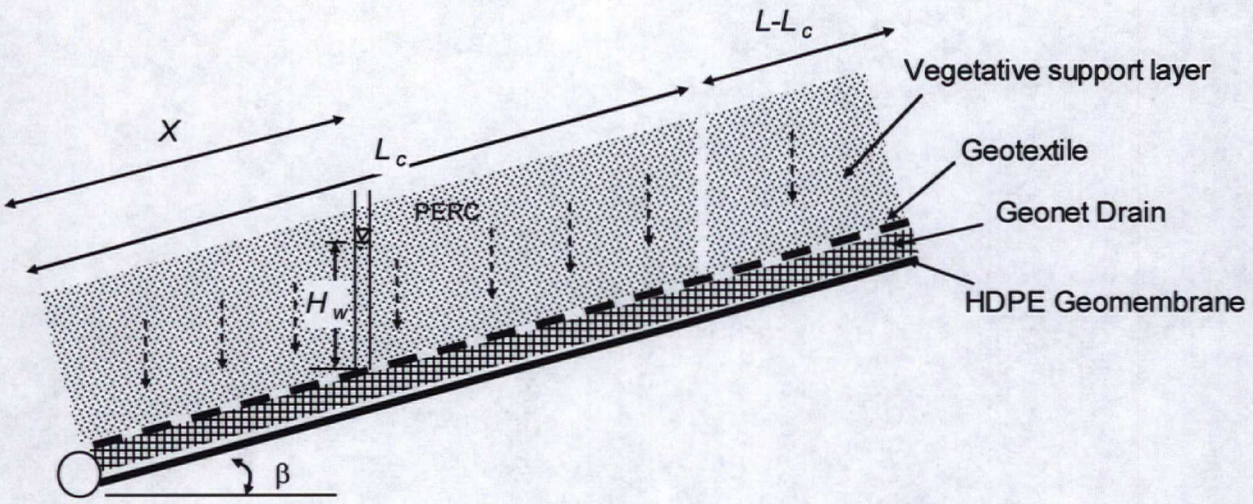


Figure 6. Geonet drainage system with excess pore pressure head H_w

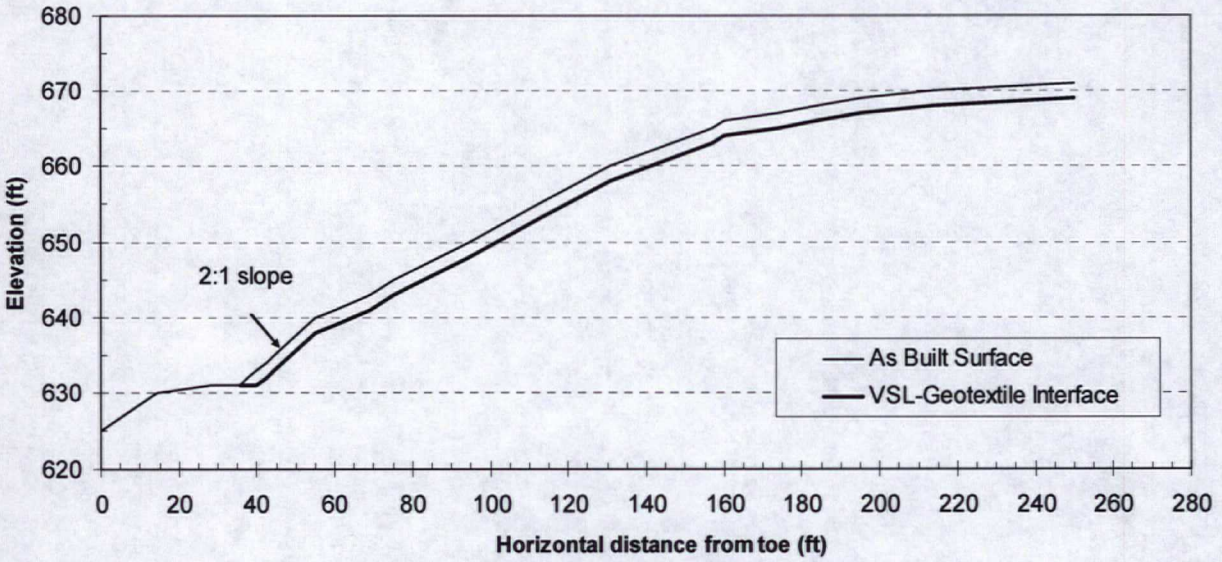


Figure 7. The as-built slope cross-section

The as-built slope between x=40 and x=55 ft (see Figure 7) is about 2:1 (horizontal:vertical) and able to discharge the rain water flow into it. Assuming zero pore pressure at x=55 ft, the excess pore pressure head along the geonet surface with no cracks in the cover soil can be obtained at the peak recorded precipitation rate of 1.10 in/hr and for different hydraulic conductivity values of the cover soil as shown in Figure 8. When $k_{cs} > 1.22\times10^{-4}$ cm/sec (1.74×10^{-1} in/hr), the geonet drain will not be able to discharge all of the infiltration into it and there will be excess pore pressure head created. As k_{cs} increases, the excess pore pressure head will be higher and will act over a longer portion of the geonet surface. The quantities of water required to generate the pore pressure are small. For every increase in H_w of 1 ft, the water must fill the geonet to a point along the slope 1 ft vertically higher. Since the slope is 4:1 (horizontal:vertical), each foot of elevation increase implies a slope length of 4.12 ft. Since the geonet has a thickness of 0.2 inches and a

porosity of 0.83, 4.12 ft of geonet has a void volume equal to 0.057 ft^3 per foot of slope width – equivalent to less than one half gallon of water.

Using the average excess pore pressure head over the 30 ft of the slope with the highest pore pressures, the factor of safety (FS) of the slope against sliding along different interfaces can be estimated employing the corresponding shear strength parameters as listed in Table 1. Figure 9 shows the variation of FS against sliding along different interfaces for various hydraulic conductivity values of the cover soil. At k_{cs} of about 1.46×10^{-4} cm/sec (2.06×10^{-1} in/hr), excess pore pressure will be created along the geonet surface and the excess pore pressure would cause about 30 ft of the slope (between x=73 and x=103 ft) to slide a small distance along the geotextile-geonet interface.

Table 1: Summary of strength parameters.

Material	Peak		Residual		Remark
	c (psf)	ϕ (deg)	*c* (psf)	ϕ (deg)	
Vegetative support layer (VSL)	109.4	31.0			New test
VSL-geotextile interface	26.0	32.9	37.0	29.2	New test
Geotextile-geonet interface	0	16.2[a]	0	14.7	New test [b]
Geonet-geomembrane interface	4.0	18.0	1.0	16.0	Ormet quality control test
Geomembrane-geosynthetic clay liner (GCL)	19.0	32.0	17.0	22.0	Ormet quality control test

[a] Corresponding to the initial yielding (see Figure 10)

[b] If the geonet is removed and replaced over large areas, either with a different geonet or a composite drain, then the interface friction angle for the new interface will be determined by new interface friction tests.

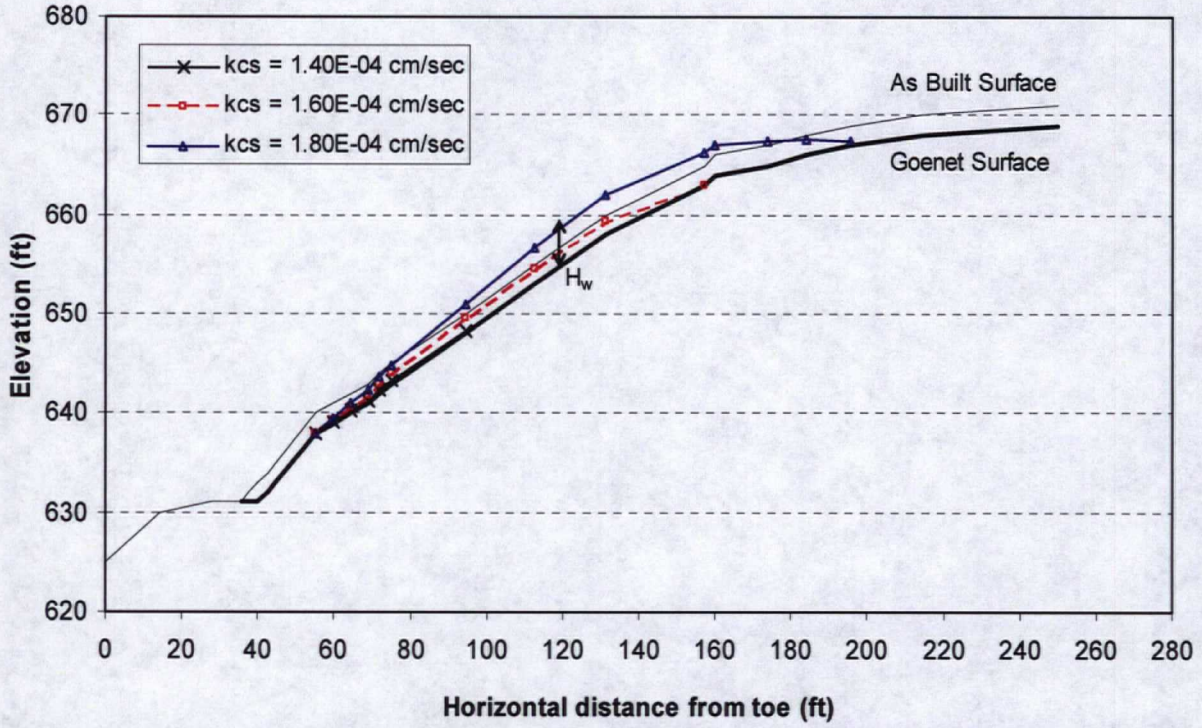


Figure 8. Distribution of excess pore pressure along the geonet surface at peak precipitation rate of 1.10 in/hr between June 1998 and June 2006.

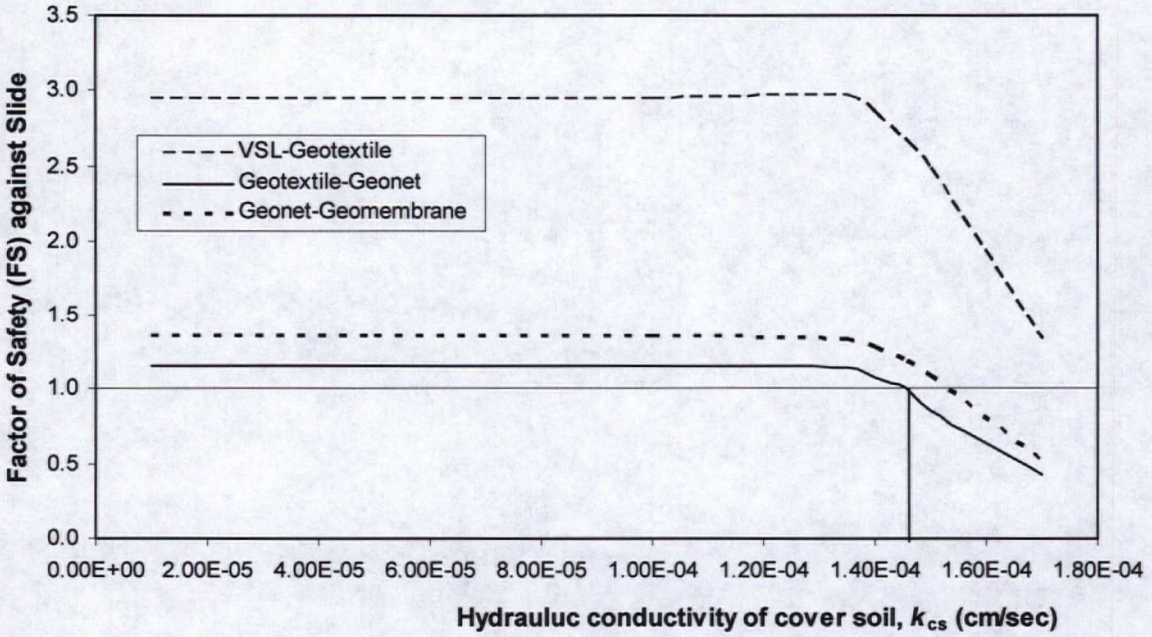


Figure 9. Factor of safety (FS) of slope against slide along different interfaces.

The sliding would pull the geotextile tight, and the tension force of the geotextile would resist further sliding along the geotextile-geonet interface. Considering the tensile strength of the geotextile, the FS of the 30 ft slope section against sliding along the geotextile-geonet interface would be increased from 1.0 to 1.77. It is also noted that the shear resistance increases significantly after initial yielding (minor sliding) along the geotextile-geonet interface (see Figure 10). So after minor sliding along the geotextile-geonet interface, increased frictional resistance and tension in the geotextile would cause the sliding along the geotextile-geonet interface to stop. The minor displacement along the geotextile-geonet interface would be enough to create minor cracks in the VSL.

Once initial cracking has occurred, additional cracking can be caused by lower rainfall intensities. The cracks in the VSL caused by minor sliding along the geotextile-geonet interface would allow surface runoff to flow directly into the geonet drain, adding to the original flow from infiltration. With a crack at about x=103 ft and at $k_{cs} = 1.46\times10^{-4}$ cm/sec (2.06×10^{-1} in/hr), excess pore pressure along the geonet surface would be created even at a precipitation rate of about 0.193 in/hr which is much smaller than the peak precipitation rate of 1.10 in/hr between June 1998 and June 2006 (see Figure 11). The excess pore pressure head will lead to minor sliding along the geotextile-geonet interface above the crack. Although more cracks will be created in the cover soil in the upper part of the slope, tension in the geotextile will cause the sliding along the geotextile-geonet interface to stop.

Once cracks occur higher on the slope, the pore pressure buildup will cause the slope to slide along the VSL-geotextile interface. With cracks at about x=130 ft, rainfall at 0.292 in/hr would lead to an average excess pore pressure of 3.16 ft above the geonet between x=119 and x=149 ft. At the average excess pore pressure of 3.16 ft, the FS of the VSL-geotextile interface against sliding drops to 1.00 while the FS of the geotextile-geonet interface against sliding is 1.04,

considering the tensile strength of geotextile. The CMSD landfill cap failure along the VSL-geotextile interface was most likely caused by the heavy rain of 0.324 in/hr on June 2, 2006, but the slope had probably developed cracks in the VSL before then.

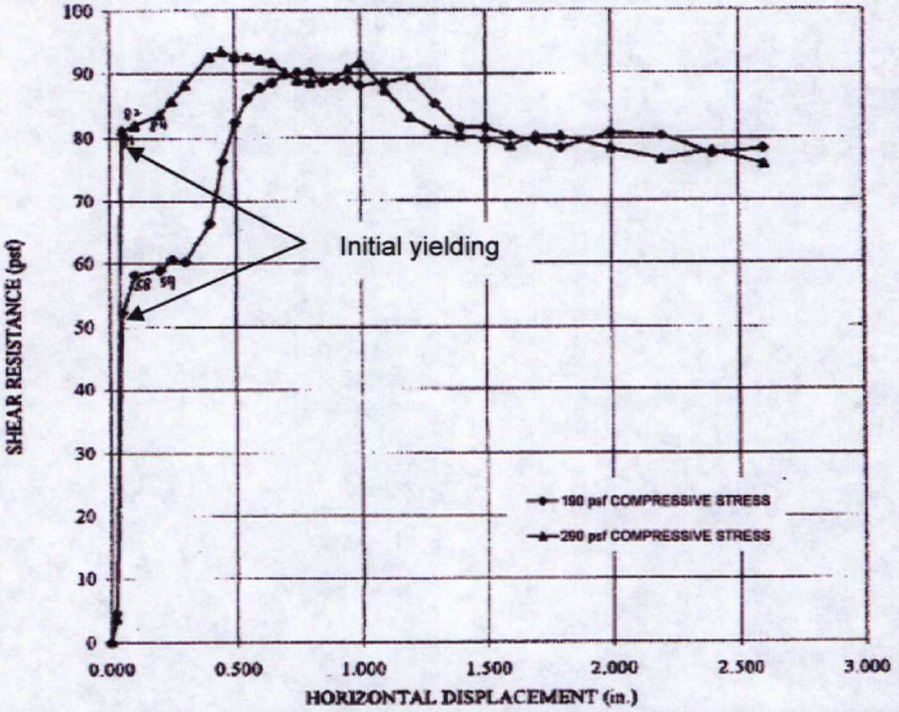


Figure 10. Shear resistance versus shear displacement along geotextile-geonet interface

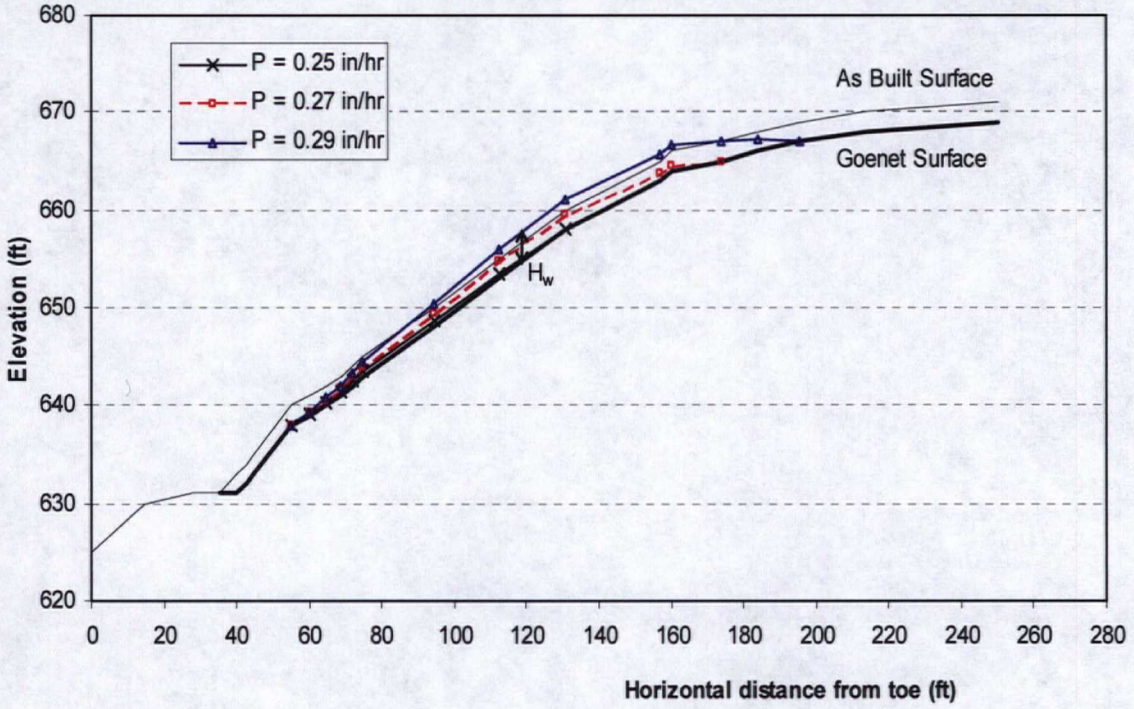


Figure 11. Distribution of excess pore pressure along the geonet surface with a crack at x=48 ft and at $k_{cs} = 1.46\times10^{-4}$ cm/sec (2.06×10^{-1} in/hr).

The total slope length has a significant effect on the maximum rain water flow into the geonet drain [see equation (5)]. To increase the FS for the geonet drain and thus the FS of the slope against slidinge, mid-slope discharge can be installed by daylighting the geonet drain at the middle of the entire riverside slope (see Figure 12). The water that comes out of the drainage layer from the mid-slope discharge will be adequately carried along the midslope diversion channels to one of the downchutes.

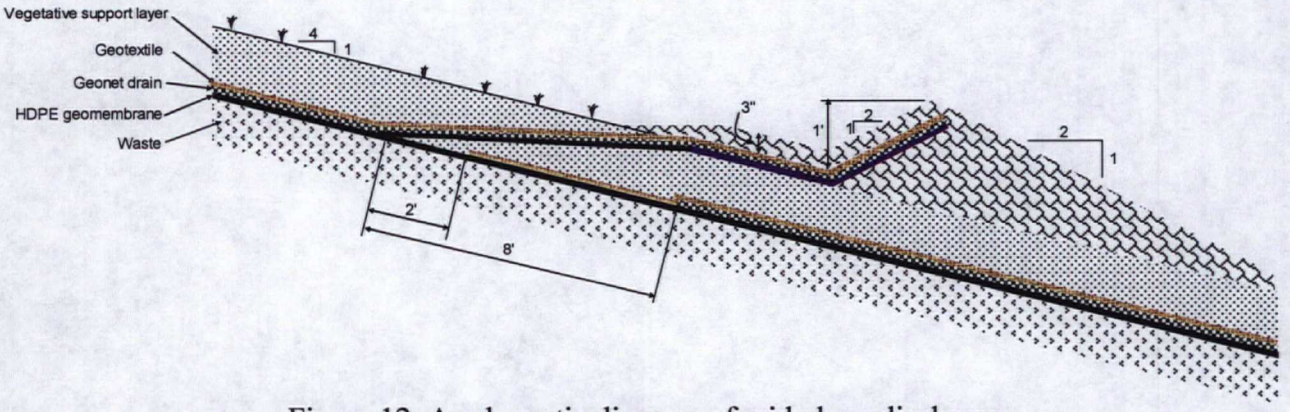


Figure 12. A schematic diagram of mid-slope discharge

The discharge capacity at the toe is also an important factor affecting the pore pressure buildup and thus the slope stability. For the failed area, the toe drain as shown in Figure 13 will be installed during the permanent repair. For the unfailed area, the existing perimeter drain pipes will be connected to an outlet pipe perpendicular to the perimeter drain pipe at each side of the failed area. The outlet pipes will be connected to the perimeter drain pipe with elbows. The design presumes that the perimeter drain pipe was installed along the toe according to the original design. The existence of the perpendicular outlet pipes has been verified in the field, and it is unlikely that the perpendicular outlet pipes would have been installed without the perimeter drain pipe. During removal of the failed VSL soil, the perimeter drain pipe will be exposed and documented, in particular to determine the details of the transition from the geonet to the perimeter drain pipe. The conditions of the existing geonet and perimeter drain pipe will be inspected to identify any signs of flow restrictions. If the existing drainage system does not conform to our current understanding, or if the investigations suggest potential malfunction of the system, additional exploration pits will be dug along the toe to expose additional parts of the drainage system. If the perimeter drain pipe does not exist or if there is evidence of system malfunction, the toe drain shown in Figure 13 will also be installed in the unfailed area.

2.3 Slope Stability Analysis – As-Built Slope Profile

In this section, the as-built slope profile is used to evaluate the factor of safety against failure with the slope stability computer software UTEXAS2. The results show that rainfall at 0.297 in/hr would lead to excess pore pressure rise above the geonet and cause the slope to slide along

the VSL-geotextile interface (see Figure 14). Since the UTEXAS2 slope stability analysis considers the resistance from the VSL (the upper side and the lower side of the slide surface), the rain rate required for failure is a bit higher than that from the infinite slope analysis. The results confirm that heavy rain of 0.324 in/hr on June 2, 2006 would have been sufficient to cause the observed failure along the VSL-geotextile interface.

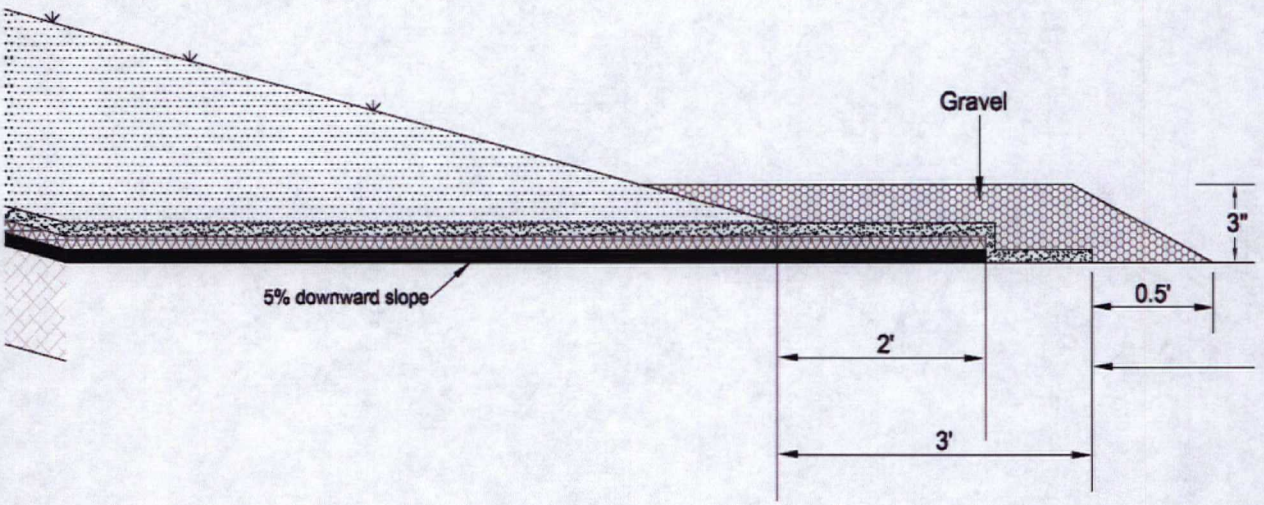


Figure 13. A schematic diagram of toe-drain

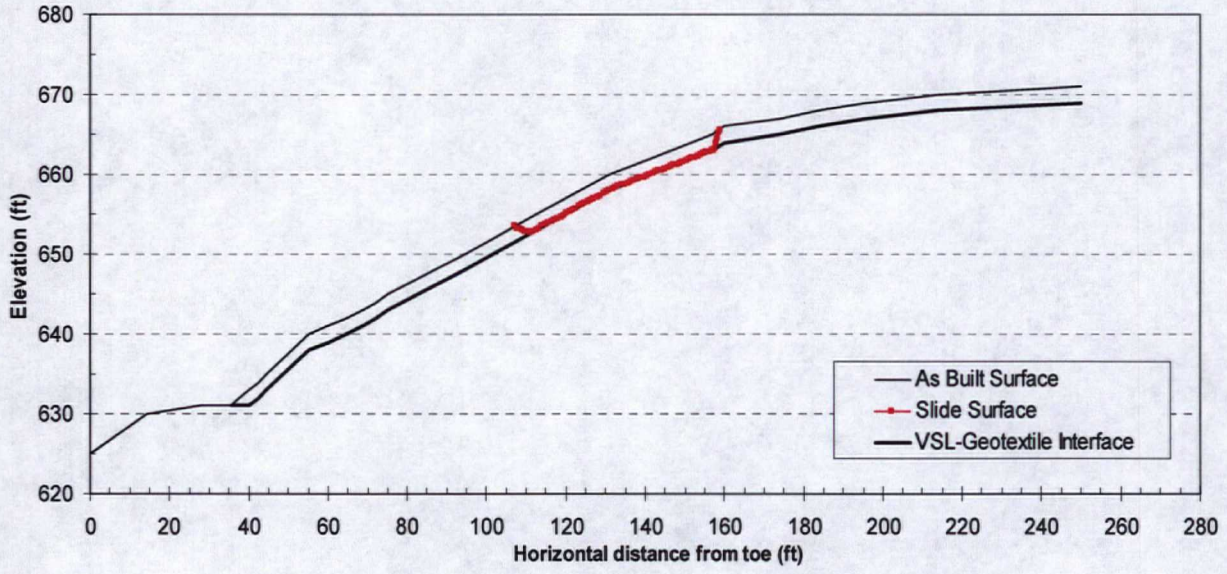


Figure 14. Slide surface from UTEXAS2 analysis.

3. Repair of CMSD Cap

The procedures for repairing the CMSD cap are presented in Appendix A. The scope of work includes the following major activities:

- Removal of failed slope material
- Removal of temporary slope protection
- Repair of geomembrane, if needed
- Repair or replacement of geonet and geotextile
- Reconstruction of the vegetative support layer
- Construction of slope toe drain
- Construction of midslope drain
- Reconstruction of midslope diversion channels
- Repair of any open cracks in the VSL
- Replacement of rip-rap for riverbank protection
- Seeding

All work is subject to the inspection, approval, and acceptance of the designated Ormet Technical Representative.

4. Monitoring and Maintenance

Monitoring and maintenance of the CMSD cap are important for its future stability. The following presents guidelines for the required monitoring and maintenance.

4.1 Inspection

Periodic inspections of the CMSD cap can provide confirmation of proper cap performance and early warning of any malfunctions. Inspections should be performed on foot and look specifically for cracks, erosion damage, animal holes, seepage, subsidence, and any other signs of distress of or changes in the cap. Cracks may be caused by wet-dry or freeze-thaw cycles, or may be an indication of slope instability. Holes may be caused by burrowing animals. Seepage may indicate a problem with the drainage layer. The capping system may exhibit differential settlements that cause ponding of water and increase infiltration.

The inspections should be done following mowing and during other times when visibility permits observing the ground surface, such as in the early spring. The inspection should cover the cap area in sufficient detail to observe linear features less than 10 ft long. The routes used to traverse the cap should vary between inspections to reduce the probability of missing the same areas repeatedly. It is often beneficial to have different inspectors inspect the cap periodically for the same reason. The inspections should be documented on scaled drawings of the CMSD cap, with any identified features located and described in sufficient detail to locate them again and to detect changes.

4.2 Instrumentation

4.2.1 Piezometer Data Loggers

Since the buildup of pore pressures on top of the geonet caused the partial failure of the CMSD cap, installation of piezometer data loggers is recommended for monitoring the pore pressures on top of the geonet. Three piezometer data loggers can be installed evenly along the width close to the toe. The protective pipes need to be clearly marked and protected from damage during mowing. Figure 14 shows how the piezometer data logger should be installed on top of the geonet. If the geonet drain works properly and its discharge rate is higher than the maximum inflow rate from precipitation infiltration, the piezometer data loggers will record zero pore pressures. If the piezometer data loggers record positive pore pressures, it indicates that the geonet drain is not able to discharge all of the inflow water from precipitation infiltration. If positive pore pressures are recorded, additional inspections should be carried out to determine whether there are cracks which have allowed greater inflow from precipitation.

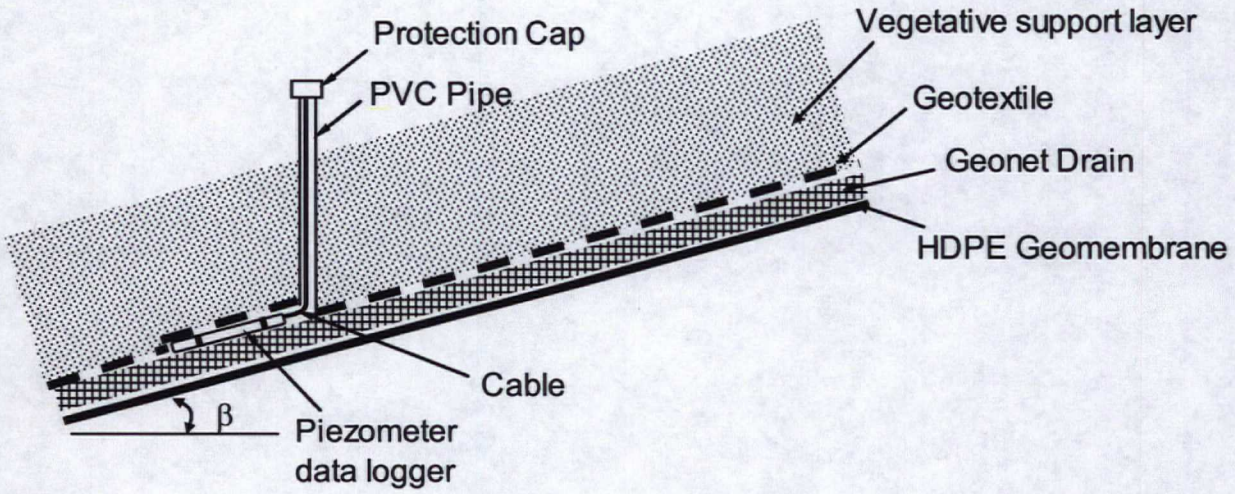


Figure 14. Piezometer data logger installed on top of the geonet

4.2.2 Displacement Monitors

In order to monitor early signs of any downslope movement of the CMSD cap materials, we recommend the placement of three lines of displacement monitors parallel to the slope crest at different heights upon the slope. Each displacement monitor can be a simple wooden stake, 18" to 24" long, driven 12 inches into the VSL. The stakes need to be clearly marked and protected from damage during mowing. Placing a layer of gravel or mulch around the base of the stakes may help limit vegetation growth. The stakes will be placed initially along three straight lines as determined by survey or laser alignment, with a spacing of 50 ft or less between stakes. The first and last stakes will be placed far enough from the repaired zone to be reasonably certain that they are not themselves within a zone of movement. The top of each stake will be permanently marked where the alignment line, defined by two points on the initial and final stakes, crosses the surface of the stake. During subsequent readings by reestablishing the alignment line between the points on the initial and final stakes, the deviation of the intermediate points from the alignment line, if any, will be recorded.

4.3 Maintenance

Routine maintenance includes the following:

- Vegetation control
- Erosion related maintenance
- Crack related maintenance
- Subsidence related maintenance

Vegetation maintenance includes periodic irrigation and fertilization, as least until vegetation is established, reseeding or replanting areas where vegetation has failed, cutting young trees before they get too large and their roots disturb the cover system components, and mowing.

Surface erosion, primarily by water, has been a problem for a number of cover systems. Visual inspection of the surface for erosion should be conducted monthly and after major rain storms. It is important that eroded areas be repaired in a timely manner after they are observed to prevent progressive erosion and damage to cover system components. It is easier to repair minor erosion rills prior to their development into larger erosion gullies.

Crack repair should follow the specifications for the temporary repair. A vigilant inspection program should limit any cracking to small, partially penetrating cracks. The instrumentation should help to determine whether the cracking is caused by widespread instability or by local conditions.

Whenever differential settlement causes ponding, the surface should be recontoured to eliminate the ponding condition. Animals should be removed from their holes and the holes should be backfilled.

4.4 Monitoring and Maintenance Schedule

The monitoring and maintenance schedule is summarized in Table 2.

Table 2: Monitoring and maintenance schedule

Component	Frequency	Methods
Inspection	Monthly and after major storms	Visual
Pore pressures	Monthly and after major storms	Piezometer data loggers
Displacement	Quarterly	Displacement monitors
Mowing	Periodically during growing season as necessary to permit visual inspection for cracks.	Power mowers, grass trimmers around instruments

5. References

Koerner, R. B. (1998). *Designing with Geosynthetics*. 4th ed. Prentice Hall, NJ.

Koerner, R.B., and Daniel, D. E. (1997). *Final Covers for Solid Waste Landfills and Abandoned Dumps.* ASCE Press, Reston, VA.

National Seal Company (no date), Poly-Net® PN3000 – Production Description, P3-0895.

Richardson, G. N., Giroud, J.P., and Zhao, A. (2000). *Design of Lateral Drainage Systems for Landfills (Draft)*.

United States Environmental Protection Agency (USEPA) (2004). *(Draft) Technical Guidance for RCRA/CERCLA Final Covers*. Office of Solid Waste and Emergency Response, EPA 540-R-04-007, OSWER 9283.1-26, April 2004.

Appendix A

Ormet Primary Aluminum Corporation

CMSD Landfill Cap Repair

Construction Specifications

ICF INTERNATIONAL

REG.026156.0.002

PROJECT TABLE OF CONTENTS

-- End of Project Table of Contents --

DOCUMENT 00 41 00

BID SCHEDULES
04/06

PART 1 GENERAL

1.1 BASIS OF BIDS

Estimated quantities presented below are for bidding purposes only. Payments for unit priced items will be based on actual, approved quantities installed in accordance with the drawings and specifications and accepted by the Owner's Technical Representative.

Item	Description	Estimated Quantity	Unit	Unit Price	Extended Amount
1.1.1	Mobilization and Site Preparation	1 Job	LS	N/A	$_____
1.1.2	Removal of Temporary Slope Protection	1 Job	LS	N/A	$_____
1.1.3	Site Restoration and Demobilization	1 Job	LS	N/A	$_____
1.2.1	Removal of Failed Slope Material	2000	CY	$_____	$_____
1.2.2	Geomembrane	1200	SY	$_____	$_____
1.2.3	Geosynthetic Drainage Layer	500	SY	$_____	$_____
1.2.4	Geotextile	500	SY	$_____	$_____
1.2.5	Vegetative Support Layer	1700	CY	$_____	$_____
1.2.6	Gravel for Slope Drains	40	CY	$_____	$_____
1.2.7	HDPE Pipe	40	LF	$_____	$_____
1.2.8	Midslope Diversion Berms	300	LF	$_____	$_____
1.2.9	Midslope Diversion Channels	330	LF	$_____	$_____
1.2.10	Rip-Rap for Riverbank Protection	120	SY	$_____	$_____
1.2.11	Seeding	4000	SY	$_____	$_____
			Total Estimated Amount		$_____

In the event there is a difference between a unit price and the extended total, the unit price will be held to be the intended bid. If the bidder

shows only the total price but fails to enter a unit price, the total divided by the estimated quantity will be held to be the intended unit price.

-- End of Document --

SECTION 01 11 00

SUMMARY OF WORK
06/06

PART 1 GENERAL

1.1 SUMMARY

On or about 13 June 2006, field maintenance personnel detected a partial failure of the Ormet Primary Aluminum Corporation (Ormet) Construction Materials Scrap Dump (CMSD) landfill multilayer cap on the river (southern) side of the CMSD landfill.

The multilayer cap consists of the following layers, listed from the top down:

- 2.0 to 2.4 ft. vegetative support layer (VSL)
- Nonwoven geotextile filter fabric (Synthetic Industries Geotex 801)
- Geonet drainage layer (Poly-Net PN3000)
- 40 mil textured HDPE geomembrane (Columbia Geosystems)
- Geocomposite clay layer (GCL) (Bentofix NS)

The primary sliding surface lies along the interface above the nonwoven geotextile and below the VSL.

The work to be performed under this project consists of providing the labor, equipment, and materials to remove displaced material from the failed area of the CMSD multilayer cap and to repair the landfill cap in accordance with the Contract Documents.

The work consists of earthwork, sitework, and other items defined in the Contract Documents.

NOTE: To protect the HDPE geomembrane, no stakes for survey control, silt fence support, material placement, or other uses shall be used on the CMSD landfill cap without the written auth0rization of the Owner's Representative.

1.2 PROJECT DESCRIPTION

The Project includes the activities and items listed below:

- Mobilization and Site Preparation , including clearing of trees and brush along the riverbank for access to the failed area of the CMSD landfill cap (Section 31 10 00), preparation of access road (Section 31 10 00), fence removal (Section 31 10 00), and erosion control (Section 31 25 13).
- Removal of Temporary Slope Protection (Section 31 10 00)
- Removal of Failed Slope Material (Section 31 00 00)
- Geomembrane (Section 31 05 19)
- Geonet (Section 31 05 19)
- Geotextile(Section 31 05 19)
- Vegetative Support Layer (Section 31 00 00)
- Gravel for Slope Drains (Section 31 00 00)
- HDPE Pipe (Section 31 00 00)
- Midslope Diversion Berms (Section 31 00 00)
- Midslope Diversion Channels (Section 31 00 00)
- Rip Rap for Riverbank Protection (Section 31 00 00)
- Seeding (Section 32 00 00)

- Site Restoration and Demobilization (Section 32 00 00)

1.3 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Existing site descriptions, measurements, quantities, and elevations presented in the Contract Documents are believed to be correct, but it shall be the Contractor's option to visit the site and the Contractor's responsibility to inspect the site and to confirm the existing site conditions to the Contractor's satisfaction prior to submittng a bid.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered within the CMSD landfill cap, however pipes or other utilities may underly access roads.

d. Groundwater will not be encountered on the slopes of the CMSD cap. Groundwater elevation is less than 10 feet below the existing surface elevation between the toe of the CMSD landfill cap and the river.

g. Borrow material in the quantities required is not available at the project site.

1.4 EXISTING WORK

The Contractor shall protect existing vegetation, structures, equipment, utilities, pavement and improvements.

The Contractor shall remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.

The Contractor shall repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Owner's Representative. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

1.5 CONTRACT DRAWINGS

The following drawings accompany this specification and are a part thereof.

Drawing No. 1 CMSD Landfill, Plan View
Drawing No. 2 Cross Sections

Contractor shall immediately check furnished drawings and notify Ormet's Representative of any discrepancies.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 22 00

MEASUREMENT AND PAYMENT
04/06

PART 1 GENERAL

1.1 LUMP SUM PAYMENT ITEMS

Payment items for the work of this contract for which contract lump sum payments will be made are listed in the BIDDING SCHEDULE and described below. All costs for items of work, which are not specifically mentioned to be included in a particular lump sum or unit price payment item, shall be included in the listed lump sum item most closely associated with the work involved. The lump sum price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for which separate payment is not otherwise provided.

1.1.1 Mobilization and Site Preparation
(No Section reference)

1.1.1.1 Payment

Payment will be made for costs associated with operations necessary for mobilization and site preparation, including clearing of trees and brush along the riverbank for access to the failed area, preparation of access road, fence removal, and erosion control.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Removal of Temporary Slope Protection
(No Section reference)

1.1.2.1 Payment

Payment will be made for costs associated with the removal and disposal of materials used for temporary slope protection.

1.1.2.2 Unit of Measure

Unit of measure: lump sum.

1.1.3 Site Restoration and Demobilization
(No Section reference)

1.1.3.1 Payment

Payment shall be made at the contract lump sum price which shall be full compensation for removal of temporary construction signs and fencing, removal of erosion control measures, removal of any temporary facilities, removal of equipment, reconstruction of permanent fencing, final site restoration, and final site cleanup. This item includes all work and

expenses incidental thereto, for which payment is not provided under other items.

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.2 UNIT PRICE PAYMENT ITEMS

Payment items for the work of this contract on which the contract unit price payments will be made are listed in the BIDDING SCHEDULE and described below. The unit price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for each of the unit price items.

1.2.1 Removal of Failed Slope Material
(Section 31 00 00)

1.2.1.1 Payment

Payment will be made for costs associated with operations necessary for the removal of soil, riprap, vegetation, and other displaced materials, including haul and disposition.

1.2.1.2 Measurement

The total quantity of excavated material for which payment will be made will be determined by truck count as approved by the Owner's Representative.

1.2.1.3 Unit of Measure

Unit of measure: cubic yard.

1.2.2 Geomembrane
(Section 31 05 19)

1.2.2.1 Payment

Payment will be made for costs associated with furnishing, transporting, and installing geomembrane as specified.

1.2.2.2 Measurement

The total quantity of geomembrane for which payment will be made will be area of geomembrane installed and approved by the Owner's Representative. No allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

1.2.2.3 Unit of Measure

Unit of measure: square yard.

1.2.3 Geosynthetic Drainage Layer
(Section 31 05 19)

1.2.3.1 Payment

Payment will be made for costs associated with furnishing, transporting, and installing geonet drainage material as specified.

1.2.3.2 Measurement

The total quantity of geonet for which payment will be made will be area of geonet installed and approved by the Owner's Representative. No allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

1.2.3.3 Unit of Measure

Unit of measure: square yard.

1.2.4 Geotextile
(Section 31 05 19)

1.2.4.1 Payment

Payment will be made for costs associated with furnishing, transporting, and installing geotextile as specified.

1.2.4.2 Measurement

The total quantity of geotextile for which payment will be made will be area of geotextile installed and approved by the Owner's Representative. No allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

1.2.4.3 Unit of Measure

Unit of measure: square yard.

1.2.5 Vegetative Support Layer
(Section 31 00 00)

1.2.5.1 Payment

Payment shall be made at the contract unit price which shall be full compensation for all labor, equipment, tools, and other materials required to furnish, transport, place, grade, and compact soil for the Vegetative Support Layer (VSL) in accordance with the Specifications. Payment under this item include the development of borrow sources, purchase of borrow soil, all offsite and onsite handling, excavation, hauling, stockpiling, loading, unloading, spreading, compaction, testing, and other work required to construct the Vegetative Support Layer. This item excludes any payment for VSL soil replaced as part of the construction of the Midslope Diversion Channel. This item encompasses all work and expenses incidental thereto, for which payment is not provided under other items.

1.2.5.2 Measurement

The total quantity of VSL soil for which payment shall be made will be the volume placed in accordance with the Specifications.

1.2.5.3 Unit of Measure

Unit of measure: cubic yard

1.2.6 Gravel for Slope Drains
(Section 31 00 00)

1.2.6.1 Payment

Payment shall be made at the contract unit price which shall be full compensation for all labor, equipment, tools, and other materials required to furnish, transport, place, and grade gravel for the Slope Toe Drain and the Midslope Diversion Channel in accordance with the Specifications. Payment under this item include the purchase of gravel, compliance testing of gravel, all offsite and onsite handling, stockpiling, loading, unloading, spreading, and grading of the gravel. This item encompasses all work and expenses incidental thereto, for which payment is not provided under other items.

1.2.6.2 Measurement

The total quantity of gravel for which payment shall be made will be the theoretical area of the gravel cross section of the Slope Toe Drain shown in the drawings multiplied by the length of the Slope Toe Drain installed along the toe of the slope plus the theoretical area of the gravel cross section of the Midslope Drain shown in the drawings multiplied by the length of the Midslope Drain installed along the midslope diversion channel.

1.2.6.3 Unit of Measure

Unit of measure: cubic yard

1.2.7 HDPE Pipe
(Section 31 00 00)

1.2.7.1 Payment

Payment shall be made at the contract unit price which shall be full compensation for all labor, equipment, tools, and other materials required to furnish, transport, prepare, and place HDPE pipe for the Perimeter Toe Drain or transitions to the Slope Toe Drain in accordance with the Specifications. Payment under this item include the purchase of HDPE pipe, all offsite and onsite handling, stockpiling, loading, unloading, preparation, and installation of the pipe. This item encompasses all work and expenses incidental thereto, for which payment is not provided under other items.

1.2.7.2 Measurement

The total quantity of HDPE pipe for which payment shall be made will be the length placed in accordance with the Specifications.

1.2.7.3 Unit of Measure

Unit of measure: linear foot

1.2.8 Midslope Diversion Berms
(Section 31 00 00)

1.2.8.1 Payment

Payment will be made for costs associated with constructing midslope diversion berms. Payment includes all costs associated with furnishing, transporting, stockpiling (if applicable), and placing materials required to construct the midslope diversion berms as specified.

1.2.8.2 Measurement

The total quantity of midslope diversion berms for which payment will be made will be the length of midslope diversion berms constructed as specified and approved by the Owner's Representative.

1.2.8.3 Unit of Measure

Unit of measure: linear foot.

1.2.9 Midslope Diversion Channels
(Section 31 00 00)

1.2.9.1 Payment

Payment will be made for costs associated with constructing midslope diversion channels. Payment includes all costs associated with excavating VSL soil above the existing upper diversion berm to expose the geomembrane, as well as furnishing, transporting, stockpiling (if applicable), and backfilling VSL soil required to construct the midslope diversion channels as specified. This item excludes the costs of geosynthetic materials and gravel.

1.2.9.2 Measurement

The total quantity of midslope diversion channel for which payment will be made will be the length of midslope diversion channel constructed as specified and approved by the Owner's Representative.

1.2.9.3 Unit of Measure

Unit of measure: linear foot.

1.2.10 Rip-Rap for Riverbank Protection
(Section 31 00 00)

1.2.10.1 Payment

Payment will be made for costs associated with restoring the riverbank protection. Payment includes all costs associated with furnishing, transporting, stockpiling (if applicable), and placing materials required to construct the riverbank protection as specified.

1.2.10.2 Measurement

The total quantity of riverbank protection for which payment will be made will be the area of riverbank protection restored as specified and approved by the Owner's Representative.

1.2.10.3 Unit of Measure

Unit of measure: square yard.

1.2.11 Seeding
(Section 32 00 00)

1.2.11.1 Payment

Payment shall be made at the contract unit price which shall be full compensation for all labor, equipment, tools, and other materials required to prepare the ground surface for seeding, including to furnish and to place grass seed, fertilizer, and mulch in all disturbed areas requiring restoration. This item includes maintaining new seeding through the contract maintenance period. This item includes all work and expenses incidental thereto, for which payment is not provided under other items.

1.2.11.2 Measurement

The quantity to be measured shall be the actual area requiring seeding as measured by the Contractor and approved by the Owner's Representative.

1.2.11.3 Unit of Measure

Unit of Measure: Square yard

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01 33 00

SUBMITTAL PROCEDURES
10/06

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections.

SD-01 Preconstruction Submittals

Information supplied by the Contractor related to procedures for executing the Project, such as proposed subcontractors, work plans, health and safety plans, construction quality control plans, and schedule.

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-06 Test Reports

Report by a testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

SD-11 Closeout Submittals
Special requirements necessary to properly close out a construction contract, such as As Built drawings.

1.1.2 Approving Authority

All submittals are subject to the review and acceptance of the Owner's Representative. Acceptance of a submittal shall not relax or modify any of the project requirements detailed in this specification unless such modification is given to the Contractor in writing.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 35 23

OWNER SAFETY REQUIREMENTS
06/06

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 GENERAL SAFETY PROVISIONS

Contractor shall take safety and health measures in performing work under this Contract. Contractor shall meet with the Owner's Representative to develop a mutual understanding relative to administration of the safety plan. Contractor is subject to applicable federal, state, and local laws, regulations, ordinances, codes, and orders relating to safety and health in effect on the date of this Contract.

During the performance of work under this Contract, the Contractor shall comply with procedures prescribed for control and safety of persons visiting the project site. Contractor is responsible for his personnel and for familiarizing each of his subcontractors with safety requirements. Contractor shall advise the Owner's Representative of any special safety restriction he has established so that Owner's personnel can be notified of these restrictions.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 45 00

CONSTRUCTION QUALITY CONTROL
07/06

PART 1 GENERAL

1.1 SUBMITTALS

SD-01 Preconstruction Submittals
List of Proposed Subcontractors
Construction Work Plan
Construction Schedule
Construction Quality Control (QC) Plan
Health and Safety Plan

SD-03 Product Data
Geonet
Geotextile
HDPE Pipe

SD-06 Test Reports
Vegetative Soil Layer Soil
Gravel
Testing Plan and Log
Daily Production and QC Report

SD-07 Certificates
Geonet
Geotextile
HDPE Pipe
Vegetative Soil Layer Soil
Gravel

SD-11 Closeout Submittals
As-Built Drawings

1.2 PRECONSTRUCTION SUBMITTALS

At least 7 days prior to the start of construction, the Contractor shall provide to the Owner's Representative the following submittals:
List of Proposed Subcontractors that will be employed by the Contractor and a description of the services these firms will provide.
Construction Work Plan that documents the proposed construction methods, construction sequence, and responsibilities for the construction of the Project.
Construction Schedule that details the sequence of, interrelationships among, and schedule for the construction activities.
Construction Quality Control (QC) Plan that describes the responsibilities for meeting the testing, certification, and measurement requirements of the Contract Documents. The Construction Quality Control (QC) Planshall include a copy of the form for the Testing Plan and Log.
Health and Safety Plan identifying Contractor personnel responsible for site safety, and documenting Contractor's safety requirements, Contractor's safety communication and training

procedures, Contractor's safety inspection procedures, and Contractor's safety incident tracking, reporting, and improvement procedures.

1.3 PRODUCT DATA SUBMITTALS

Product Data Submittals are required for the following manufactured products. Specific requirements are listed in the referenced sections of the specifications.

Geonet (Section 31 05 19)
Geotextile (Section 31 05 19)
HDPE Pipe (Section 31 00 00)

1.4 TEST REPORT SUBMITTALS

1.4.1 Material Test Reports

The following Test Report Submittals are required. Where indicated, specific requirements are listed in the referenced sections of the specifications.

Vegetative Soil Layer Soil (Section 31 00 00)
Gravel (Section 31 00 00)

1.4.2 Testing Plan and Log

As tests are performed, the Contractor shall record on a Testing Plan and Log the date the test was performed and the date the test results were forwarded to the Owner's Representative. Deliver a copy of the updated Testing Plan and Log to the Owner's Representative each week.

1.4.3 Daily Production and QC Report

The Contractor shall deliver the Daily Production and QC Report to the Owner's Representative by 10:00 AM the next working day after each day that work is performed. The report shall include:

a. Contractor Production Data, including daily and cumulative quantities constructed or installed

b. Construction QC Data, including the results of any field tests performed or laboratory test data received

c. Problem Occurrence and Resolution Narrative, including a description of any problems or anomalies encountered and their resolution

1.5 CERTIFICATE SUBMITTALS

Certificate Submittals are required from the providers of the following manufactured and natural materials. Specific requirements are listed in the referenced sections of the specifications.

Geonet (Section 31 05 19)
Geotextile (Section 31 05 19)
HDPE Pipe (Section 31 00 00)
Vegetative Soil Layer Soil (Section 31 00 00)
Gravel (Section 31 00 00)

1.6 COMPLETION INSPECTIONS

1.6.1 Punch List Inspection

Near the completion of all work, the Contractor and the Owner's Representative shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings, specifications and Contract. Include in the punch list any remaining items on the "Rework Items List", which were not corrected prior to the Punch List Inspection. The punch list shall include the estimated date by which the deficiencies will be corrected.

1.6.2 Final Acceptance Inspection

The Contractor shall notify the Owner's Representative when all items previously identified on the pre-final punch list have been completed or corrected. The Contractor and the Owner's Representative shall conduct a final inspection of the work. If all items are completed in accordance with the specifications, drawings, and punch list, the project will be accepted for final payment.

1.7 DOCUMENTATION

1.7.1 Construction Documentation

Daily Production and QC Reports are required for each day that work is performed. Maintain current and complete records of on-site and off-site QC program operations and activities. The reporting of work shall be identified by terminology consistent with the specifications. The reports shall include pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered and a record of visitors to the work site, quality control problem areas, construction deficiencies encountered, and meetings held.

1.7.2 As-Built Drawings

The Contractor shall prepare and submit As-Built Drawings, marked to show deviations which have been made from the Contract drawings. Upon completion of work, the Contractor shall furnish a certificate attesting to the accuracy of the As-Built Drawings prior to submission to the Owner's Representative.

As-Built Drawings drawings shall incorporate contract changes and plan deviations. Lines, letters, and details will be sharp, clear, and legible. Additions or corrections to the drawings will be drawn to the scale of the original drawing.

Three reproducible copy(s) of each drawing shall be submitted for the historical record. If the As-Built Drawings are produced on a CAD system, 3 copies of the electronic files on CD or DVD shall also be submitted.

1.8 NOTIFICATION ON NON-COMPLIANCE

The Owner's Representative will notify the Contractor of any detected non-compliance with the Contract. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when

delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time for excess costs or damages by the Contractor.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PREPARATION

Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Store and handle materials in a manner as to prevent loss from weather and other damage. Keep materials, products, and accessories covered and off the ground, and store in a dry, secure area. Prevent contact with material that may cause corrosion, discoloration, or staining. Protect all materials and installations from damage by the activities of other trades.

-- End of Section --

SECTION 31 00 00

EARTHWORK
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 698	(2000ae1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(2000) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 3080	(2004)Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals
Construction Work Plan

SD-06 Test Reports

Borrow Source Assessment
VSL Soil Moisture Content and Density Tests

1.3 EQUIPMENT

Equipment used to place the select fill and topsoil layers shall be as described in the approved Construction Work Plan. The plan shall describe equipment to be used (including ground pressures). Equipment shall not accelerate or brake suddenly, turn sharply, or be operated at speeds exceeding 5.0 miles per hour.

PART 2 PRODUCTS

2.1 VEGETATIVE SUPPORT LAYER SOIL

2.1.1 VSL Soil Description

VSL soil shall consist of natural, friable soil and shall be free of debris, frozen materials, angular rocks, clay lumps, objectionable weeds, litter, brush, matted roots, chemical contamination, toxic substances, and any material that might be harmful to plant growth or be a hindrance to grading, planting, or maintenance operations.

VSL soil shall have sufficient fertility to support vegetation.

2.1.2 Classification Testing

Borrow source assessment tests shall be performed on the material proposed for use in the vegetative support layer to ensure compliance with specified requirements. At least one set of borrow assessment tests shall be performed on each borrow source proposed for use. A set of borrow source assessment tests shall consist of Atterberg limits (ASTM D 4318), particle size analysis (ASTM D 422), and moisture content (ASTM D 2216). Based on borrow source assessment testing, soils shall be classified in accordance with ASTM D 2487.

2.1.3 Moisture-Density (Compaction) Testing

A representative sample from each principal type or combination of borrow materials shall be tested to establish compaction curves using ASTM D 698. At least one compaction test shall be performed on each borrow source proposed. A minimum of 5 points shall be used to develop each compaction curve.

TABLE 1
VEGETATIVE SUPPORT LAYER SOIL TESTING FREQUENCIES

Property	Frequency (Note 1)	Test Method
Grain size analysis	Once,project start	ASTM D 422
Moisture content	Once (Note 2)	ASTM D 2216
Atterberg limits	Once,project start	ASTM D 4318
Compaction	Once,project start	ASTM D 698
Direct shear	Once,project start	ASTM D 3080

Note 1: The Owner's Representative may require additional tests if the soil characteristics of the incoming soil appear to change as the Project progresses.
Note 2: Additional moisture content tests will be taken daily as part of compaction control.

2.1.4 Chemical Contamination Certification

Borrow used for the Vegetative Support Layer shall be certified by the Contractor to be free of chemical contamination.

2.1.5 VSL Borrow Soil Acceptance Criteria

Test results must comply with the requirements listed in Table 2 or the

material will be rejected for use.

TABLE 2
REQUIRED PHYSICAL PROPERTIES OF VSL SOIL

Property	Test Value	Test Method
Soil classification	Low plasticity clay (CL)	ASTM D 2487
Max. particle size	1.0 inch	ASTM D 422
Liquid Limit	39% +/-5%	ASTM D 4318
Plasticity Index	22% +/-5%	ASTM D 4318
Friction Angle	32 degrees	ASTM D 3080

2.2 MATERIAL FOR RIP-RAP

2.2.1 Rip-Rap for Riverbank Protection

Provide rock conforming to Ohio DOT Type C for reconstruction of riverbank erosion protection. Type C material has at least 85 percent of the total material by weight larger than a 6-inch (150 mm) but less than an 18-inch (0.5 m) square opening and at least 50 percent of the total material by weight larger than a 12-inch (0.3 m) square opening. Furnish material smaller than a 6-inch (150 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

Provide rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Do not permit the inclusion of more than trace quantities of dirt, sand, clay, and rock fines.

Salvage and reuse of rip-rap disturbed by the displacement of the CMSD landfill cover soils is encouraged.

2.2.2 Rip-Rap for Midslope Diversion Berms

Provide rock conforming to Ohio DOT Type D for construction of Midslope Diversion Berms. Type D material has at least 85 percent of the total material by weight larger than a 3-inch (75 mm) but less than a 12-inch (0.3 m) square opening and at least 50 percent of the total material by weight larger than a 6-inch (150 mm) square opening. Furnish material smaller than a 3-inch (75 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

Provide rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Do not permit the inclusion of more than trace quantities of dirt, sand, clay, and rock fines.

Salvage and reuse of rip-rap disturbed by the displacement of the CMSD landfill cover soils is encouraged.

2.3 GRAVEL FOR SLOPE DRAINS

Above the midslope diversion channel, the geonet drain and geotextile will be extended across the midslope diversion channel to allow drainage of the upper portion of the slope. At the slope toe of the section to be repaired, the geonet drain and geotextile will be extended to the ground surface to allow drainage of the lower portion of the slope. The Contractor shall protect the exposed geonet and geotextile in both locations by covering the geotextile with a gravel blanket.

The gravel blanket shall have a minimum thickness of 3 inches.

Gravel for the protective gravel blanket shall meet the gradation criteria for AASHTO M43 Size No. 6. See Table 2.

Table 2
Gravel Gradation Requirements

Sieve Size in inches	Percent Finer
1	100
3/4	90 to 100
1/2	20 to 55
3/8	0 to 15
No. 4	0 to 5

2.4 WATER

Unless otherwise directed, water for moisture control of soil materials is the responsibility of the Contractor. If not prohibited by local regulations, river water may be used.

2.5 HDPE PIPE

The outlet pipes and elbows shall be nominally 4 inch diameter HDPE plastic pipe and fittings compatible with the perimeter drain pipe. All connections shall be watertight and mechanically secured by means approved by the Owner's Representative.

PART 3 EXECUTION

3.1 MATERIAL STOCKPILING

The Contractor shall stockpile and store all construction materials in a secure manner, protecting them from damage from construction traffic, water, and sun. Do not place material on surfaces that are muddy, frozen, or contain frost.

Storage or stockpiling of material on the slope will not be permitted.

3.2 VSL PLACEMENT AND COMPACTION

3.2.1 General Placement Procedures

VSL soil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading. No equipment shall be operated directly on the top surface of geosynthetics. VSL soil shall be placed in a manner that prevents soil from

entering the geotextile overlap zone. VSL soil shall be pushed out over the geotextile in an upward tumbling motion so that tensile stresses are not mobilized in the geotextile and so that wrinkles in the geosynthetics do not fold over. Soil shall not be dropped directly onto the geotextile from a height greater than 3 feet. On slopes, select fill shall be placed from the bottom of the slope upward. No equipment shall be operated directly on top of the geotextile.

Fill and backfill to contours, elevations, and dimensions indicated; to match existing lines and grades of undisturbed areas; and in accordance with the instuctions of the Owner's Representative. Compact each lift before placing overlying lift.

3.2.2 Construction Tolerances

Finished surfaces shall be uniformly graded and shall be free from depressions, mounds, or windrows. The top surface of the Vegetative Support Layer shall be no greater than 3 inches above the lines and grades shown on the drawings. No minus tolerance will be permitted. Rigid grade stakes shall not be driven into the Vegetative Support Layer to control placement.

3.2.3 Initial Lift of VSL Soil Placed Over Geosynthetics

The first lift of VSL soil placed over geosynthetics shall be a minimum of 9 inches and a maximum of 12 inches in loose thickness. Equipment with ground pressures less than 7 psi shall be used to place and traffic compact the first lift of VSL soil. Traffic compaction shall consist of a minimum of 2 passes over all areas. Compact areas not accessible to rollers or compactors with mechanical hand tampers.

3.2.4 Subsequent Lifts of VSL Soil

The loose lift thickness of each subsequent lift shall be no greater than 8 inches. Full scale placement and compaction equipment shall be allowed on areas underlain by geosynthetics after the second loose lift of soil has been placed. Compaction shall consist of a minimum of 2 passes over all areas.

3.2.5 Construction Quality Assurance Testing

3.2.5.1 Test Frequencies and Locations

Each day that select fill is placed, a minimum of one set of field moisture content and density tests shall be performed.

3.2.5.2 Test Results

Placement of select fill shall conform to the following requirements:

a. The minimum allowable dry density shall be no less than 85 percent of maximum dry density obtained by the test procedure presented in ASTM D 698. Density requirements may be waived for the first lift of the Vegetative Support Layer at the discretion of the Owner's Representative.

b. The allowable moisture content range shall be +/- 3 percent of the optimum moisture content obtained by the test procedure presented

in ASTM D 698.

Field moisture content and density test results shall be compared to the compaction curve for the appropriate material type being tested. If test results are not within the acceptable range for moisture content or density, the lift of soil shall be recompacted or reworked to meet the specifications. The area shall then be retested.

The Contractor will advise the Owner's Representative of the VSL soil moisture content and density tests prior to placing the following lift.

3.3 RIP-RAP PLACEMENT

3.3.1 Rip-Rap for Riverbank Protection

The Contractor shall restore rip-rap for riverbank protection in the area disturbed by the failure of the CMSD landfill cap. Limits for rip-rap restoration shall be determined in the field with the Owner's Representative.

The Contractor shall place rip-rap for riverbank protection to a minimum thickness of 1.5 feet and a maximum slope of 2:1 (horizontal:vertical).

The Contractor shall place rock for rip-rap to produce a well graded mass with the minimum practicable percentage of voids.

3.3.2 Rip-Rap for Midslope Diversion Berms

The Contractor shall restore rip-rap for midslope diversion berms in the area disturbed by the failure of the CMSD landfill cap. Limits for rip-rap restoration shall be determined in the field with the Owner's Representative.

The Contractor shall place rip-rap for midslope diversion berms to provide a minimum channel depth of 1 foot and a maximum slopes of 2:1 (horizontal:vertical), both upslope and downslope.

The Contractor shall place rock for rip-rap to produce a well graded mass with the minimum practicable percentage of voids.

3.4 SLOPE TOE DRAIN

3.4.1 Description

The original CMSD landfill cap construction included a 4 inch diameter corrugated plastic perimeter drain pipe along the toe of the slope with several perpendicular outlet pipes. The current Project eliminates the perimeter drain pipe in the reconstructed section, but requires the installation of outlet pipes at the ends of the perimeter drain pipe at the sides of the failed section.

3.4.2 Toe Drain in Reconstructed Section

The Contractor shall extend the geomembrane, geosynthetic drainage layer, and geotextile past the toe of the slope as shown in the drawings. New geomembrane shall meet the requirements of Section 31 05 19

3.4.3 Transition at Edge of Reconstructed Section

The Contractor shall install an outlet pipe perpendicular to the perimeter drain pipe at each side of the failed area. The outlet pipes shall be connected to the perimeter drain pipe with elbows.

3.5 MIDSLOPE DIVERSION CHANNEL

3.5.1 Description

The original CMSD landfill cap construction included two midslope diversion berms on the southern slope to intercept surface water runoff and to direct its flow to the downchute. The current Project modifies the geosynthetic drainage layer above the upper midslope diversion berm to achieve the following objectives:

a) hydraulically isolate the upslope and downslope portions of the geosynthetic drainage layer
b) direct water from the upslope portion of the geosynthetic drainage layer to the slope surface and the midslope diversion channel
c) decrease the quantity of water in the geosynthetic drainage layer in the downslope portion of the slope

3.5.2 Removal of Vegetative Support Layer

The Contractor shall remove the Vegetative Support Layer immediately upslope of the Midslope Diversion Berm for a distance of approximately 8 feet. The upslope side of the excavation shall be no steeper than 2:1 (horizontal:vertical). The bottom of the excavation shall have a 5% downward slope toward the Midslope Diversion Berm. The excavation shall expose the existing geotextile, geonet, and geomembrane for at least 1 foot along the slope.

The Contractor shall use methods and equipment to prevent damage to the geosyntetic materials.

3.5.3 Cutting Geotextile and Geonet

The Contractor shall cut the geotextile and geonet to separate the upstream and downstream portions.

The Contractor shall use methods and equipment to prevent damage to the geomembrane.

3.5.4 Installing Geomembrane

The Contractor shall install geomembrane as shown in the drawings. The upstream edge shall be welded to the existing geomembrane. The geomembrane shall overlie the 5% slope to the Midslope Diversion Channel, and then follow the profile of the channel.

The Contractor shall install the geomembrane in accordance with the requirements of Section 31 05 19.

3.5.5 Installing Geosynthetic Drainage Layer

The Contractor shall install geosynthetic drainage layer as shown in the drawings. The upstream edge shall be fastened to the existing geonet. The geosynthetic drainage layer shall overlie the 5% slope to the Midslope Diversion Channel, and then follow the profile of the channel.

The Contractor shall install the geosynthetic drainage layer in accordance with the requirements of Section 31 05 19.

3.5.6 Installing Geotextile

The Contractor shall install geotextile as shown in the drawings. The downsteam edge of the existing geotextile shall overlap the upstream edge of the new geotextile. The geotextile shall overlie the 5% slope to the Midslope Diversion Channel, and then follow the profile of the channel.

The Contractor shall install the geotextile in accordance with the requirements of Section 31 05 19.

3.5.7 Vegetative Support Layer

The Contractor shall reconstuct the Vegetative Support Layer to the original lines and grades.

3.5.8 Gravel Protection

The Contractor shall cover the exposed geotextile with a 3 inch layer of gravel.

3.6 PROTECTION OF EXISTING AND NEW CONSTRUCTION

3.6.1 Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Report damage to utility lines or subsurface construction immediately to the Owner's Representative.

3.6.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.6.2.1 Drainage

The Contractor shall maintain grades in the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and or drainage features as required to maintain dry soils and prevent erosion. It is the responsibility of the Contractor to assess the soil and ground water conditions at the site and to employ necessary measures to permit construction to proceed. Slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.6.2.2 Repair of Erosion Damage

Erosion rills or other damage that occurs shall be repaired and grades re-established at the Contractor's expense. Repairs to the Vegetative Support Layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

-- End of Section --

SECTION 31 05 19

GEOSYNTHETICS FOR EARTHWORK
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 638	(2003) Tensile Properties of Plastics
ASTM D 1004	(2003) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1505	(2003) Density of Plastics by the Density-Gradient Technique
ASTM D 1603	(2001) Carbon Black in Olefin Plastics
ASTM D 3786	(2001) Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
ASTM D 4218	(1996; R 2001) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4354	(1999) Sampling of Geosynthetics for Testing
ASTM D 4355	(2002) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999; R 2004) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	(2003) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile

ASTM D 4759	(2002) Determining the Specification Conformance of Geosynthetics
ASTM D 4833	(2000e1) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D 5035	(1995; R 2003) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5199	(2001) Measuring Nominal Thickness of Geosynthetics
ASTM D 5261	(1992; R 2003) Measuring Mass Per Unit Area of Geotextiles
ASTM D 5321	(2002) Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 5397	(1999e1) Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D 6392	(1999) Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GC7	(1997) Determination of Adhesion and Bond Strength of Geocomposites
GSI GRI GM12	(1998) Asperity Measurement of Textured Geomembranes Using a Depth Gauge

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Geomembrane As-Built Drawings
Final as-built drawings of geomembrane installation

SD-04 Samples

Geotextile Samples
One properly identified 24 by 24 inch minimum size geotextile sample.

Geosynthetic Drainage Layer Samples
One properly identified 24 by 24 inch minimum size geosynthetic

drainage layer sample. The fasteners proposed for use and the method of seaming and overlapping shall also be submitted.

Geomembrane Samples
One properly identified 24 by 24 inch minimum size geomembrane layer sample.

SD-06 Test Reports

Geotextile Certifications
Manufacturer's quality control test results.

Geosynthetic Drainage Layer Certifications
Manufacturer's quality control test results.

Geomembrane Tests
Manufacturer's quality control test results.

Geomembrane Laboratory Testing
Geomembrane Trial Seam Testing
Non-Destructive Field Seam Continuity Testing
Destructive Field Seam Strength Testing

Interface Friction Testing

1.3 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geosynthetics shall be in accordance with ASTM D 4873. Equipment used in performance of the work shall be in accordance with the geosynthetic manufacturer's recommendations and shall be maintained in satisfactory working condition.

1.3.1 Geotextile

The Owner's Representative shall be notified a minimum of 24 hours prior to delivery and unloading of geotextile rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

1.3.2 Geosynthetic Drainage Layer

The geosynthetic drainage layer material shall not be damaged during shipping, storage, or handling. Any drainage layer material found to be

damaged shall be repaired or replaced. Material shall be delivered only after the required submittals have been approved. Each roll shall be labelled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic. The rolls shall be stored in a level and dry area.

1.3.3 Geomembrane

1.3.3.1 Delivery

The QC inspector shall be present during delivery and unloading of the geomembrane. Each geomembrane roll/panel shall be labeled with the manufacturer's name, product identification number, roll/panel number, and roll dimensions.

1.3.3.2 Storage

Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate. The geomembrane shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll goods or flattening of the rolls. Rolls shall not be stored more than two high. Palleted materials shall be stored on level surfaces and shall not be stacked on top of one another. Ultraviolet sensitive materials shall be covered with a sacrificial opaque and waterproof covering or placed in a temporary shelter. Damaged geomembrane shall be removed from the site and replaced with geomembrane that meets the specified requirements.

1.3.3.3 Handling

Rolls/panels shall not be dragged, lifted by one end, or dropped. A pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll. Chains shall be used to link the ends of the pipe or bar to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the roll without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

PART 2 PRODUCTS

2.1 GEOTEXTILE

Geotextile shall be a nonwoven pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the

geotextile. Post-consumer recycled material shall not be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values. The Contractor shall submit Geotextile Certifications and test results from the manufacturer demonstrating that the product meets the Project specifications.

TABLE 1
PHYSICAL REQUIREMENTS FOR GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
Mass/Unit Area	oz/SY	8.0 (min)	ASTM D 5261
Grab Strength	lbs	230 (min)	ASTM D 4632
Grab Elongation	percent	50 (min)	ASTM D 4632
Puncture Strength	lbs	120 (min)	ASTM D 4833
Burst Strength	lbs/in	290 (min)	ASTM D 3786
Trapezoid Tear	lbs	95 (min)	ASTM D 4533
Apparent Opening Size	U.S. Sieve	100 (max)	ASTM D 4751
Permittivity	1/sec	1.80 (min)	ASTM D 4491
Ultraviolet Degradation	percent at 500 hrs	50 (max)	ASTM D 4355

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

2.2 GEOSYNTHETIC DRAINAGE LAYER

The polymer used to manufacture the geonet component of the geosynthetic drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used.

The Contractor may supply either separate geotextile and geonet, or a geocomposite drainage material. If a geocomposite is used, the geonet shall be covered on one side with nonwoven geotextile. Geocomposite shall be

created by heat bonding geotextile to the geonet. The geotextile shall not be bonded to the drainage net within 6 inches of the edges of the rolls.

The geosynthetic drainage layer shall conform to the property requirements listed in Table 2. Where applicable, Table 2 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV). If a geocomposite drainage material is used, the geotextile must meet the requirements in Table 1. The Contractor shall submit Geosynthetic Drainage Layer Certifications and test results from the manufacturer demonstrating that the product meets the Project specifications.

TABLE 2 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM TESTING FREQUENCY
GEONET			
Thickness, minimum avg, Note 1	ASTM D 5199	200 mil	100,000 SF
Polymer Density, minimum avg	ASTM D 1505	0.940 g/cc	100,000 SF
Carbon Black Content	ASTM D 1603 ASTM D 4218	2 percent	100,000 SF
Tensile Strength, minimum avg, Note 2	ASTM D 5035	45 lbs/in	100,000 SF
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles Note 4	ASTM D 4716	1x10E-3 m2/sec	200,000 SF
Geonet/Geotextile Adhesion, minimum avg, Note 5	GSI GRI GC7	0.5 lbs/inch	100,000 SF

Note 1: The diameter of the presser foot shall be 2.22 inches and the pressure shall be 2.9 psi. For other thickness options, see manufacturer's literature.
Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.
Note 3: Manufacturer's historical data.
Note 4: Manufacturing quality control transmissivity tests shall be measured using a gradient of 1.0 under a normal pressure of 100 psi. A minimum seating period of 15 minutes shall be used. The test shall be performed between rigid end platens.
Note 5: Average of five tests across the roll width. Discounting the outer 305 mm of each side of the roll, samples shall be collected at the 10, 30, 50, 70, and 90 percent positions across the roll width. Both sides shall be tested for double sided geocomposites.

2.3 GEOMEMBRANE

2.3.1 Raw Materials

Resin used in manufacturing geomembrane sheets shall be made of virgin uncontaminated ingredients. No more than 10 percent regrind, reworked, or trim material in the form of chips or edge strips shall be used to manufacture the geomembrane sheets. All regrind, reworked, or trim materials shall be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. No post consumer materials or water-soluble ingredients shall be used to produce the geomembrane. For geomembranes with plasticizers, only primary plasticizers that are resistant to migration shall be used. The Contractor shall submit a copy of the test reports and QC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

2.3.2 Sheet Materials

Geomembrane sheets shall be uniform in color, thickness, and surface texture. Geomembrane sheets shall be textured on the upper face. The textured surface features shall consist of raw materials identical to that of the parent sheet material and shall be uniform over the entire face of the geomembrane. The sheets shall be free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants and other imperfections. Geomembrane sheets and factory seams shall conform to the requirements listed in Table 3 and 4 for Manufacturing Quality Control (MQC).

TABLE 3. TEXTURED HDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	TEST METHOD
Nominal Thickness	40 mils	
Minimum Thickness	36 mils	
Density (min)	0.940 g/cc	ASTM D 1505
Tensile Properties		ASTM D 638 Type IV
-yield stress	84 lb/in	
-break stress	60 lb/in	
-yield elongation	12%	
-break elongation	100%	
Tear Resistance	33 lb	ASTM D 1004
Puncture Resistance	60 lb	ASTM D 4833
Carbon Black Content	2.0-3.0 %	ASTM D 1603 (3)
Asperity Height (min ave)(4)	10 mils	GSI GRI GM12

Note (1): Minimum average machine direction and minimum average cross machine direction values shall be based on 5 test specimens in each direction. For HDPE geomembrane, yield elongation is calculated using a gauge length of 1.3 inches. For HDPE geomembrane, break elongation is calculated using a gauge length of 2.0 inches. For LLDPE geomembrane, break elongation is

calculated using a gage length of 2.0 inches at 2 inches/min.

Note (2): For HDPE geomembrane, the yield stress used to calculate the applied load for test method ASTM D 5397 (Appendix), shall be the manufacturer's mean value. ASTM D 5397 does not need to be run on LLDPE geomembrane.

Note (3): Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation to ASTM D 1603 can be established.

Note (4): Textured Geomembrane Only: Of 10 readings; 8 out of 10 must be 7 mil, and lowest individual reading must be 5 mil.

TABLE 4. HDPE SEAM PROPERTIES

PROPERTY	TEST VALUE	TEST METHOD
Seam Shear Strength (min)	80 lb/in	ASTM D 6392
Seam Peel Strength (min)	60 lb/in	ASTM D 6392

Note (1): Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.

Note (2): Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.

2.4 INTERFACE FRICTION TESTING

Laboratory interface friction tests shall be conducted on the following interfaces:

Geosynthetic Drainage Layer vs. Geotextile
Geotextile vs. VSL Soil

2.4.1 Geosynthetic Drainage Layer vs. Geotextile

Tests shall be conducted in accordance with ASTM D 5321. Normal stresses of 190 psf, 237.5 psf, and 297 psf along with a displacement rate of 0.04 inches per minute shall be used. Interfaces tested shall be wet. Geosynthetics shall be the same materials as those proposed for use during full scale construction. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field. A minimum peak interface friction angle of 20.5 degrees is required for the interface.

If the contractor uses a geocomposite drainage material with geotextile heat bonded to the geonet, the manufacturer's certification of the shear strength of the bond may be substituted for this test.

2.4.2 Geotextile vs. VSL Soil

Tests shall be conducted in accordance with ASTM D 5321. Normal stresses of 190 psf, 237.5 psf, and 297 psf along with a displacement rate of 0.005 inches per minute shall be used. Interfaces tested shall be wet. Soil components shall be the same as used for full scale construction and shall be compacted to the same moisture-density requirements specified for full scale field placement. The substrate behind the geotextile shall be a

sample of the geosynthetic drainage layer. The geonet shall be oriented with the side marked "top side" facing the geotextile, and such that the direction of movement, if any, of the geotextile relative to the geonet shall be from the upslope end of the geonet towards the downslope end.Geosynthetics shall be the same materials as those proposed for use during full scale construction. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field. A minimum peak interface friction angle of 20.5 degrees is required for all interfaces.

PART 3 EXECUTION

3.1 GEOTEXTILE

3.1.1 Geotextile Samples

The Contractor shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Test method ASTM D 4355 shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

3.1.2 Placement

The Contractor shall notify the Owner's Representative a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

3.1.3 Seams and Overlaps

Geotextile panels shall be continuously overlapped a minimum of 12 inches at all longitudinal and and a minimum of 36 inches at all transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

3.1.4 Protection

The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

3.1.5 Repairs

Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a

minimum of 18 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile which cannot be repaired shall be removed and replaced. Repairs to geotextile damaged by Contractor activities shall be performed at the Contractor's expense.

3.1.6 Acceptance

Geotextile shall not be covered with VSL soil prior to inspection and approval of the geotextile by the Owner's Representative.

3.2 GEOSYNTHETIC DRAINAGE LAYER

3.2.1 Geosynthetic Drainage Layer Samples

The Contractor shall provide quality assurance samples of geonet to an Independent Laboratory. Samples will be tested to verify that geonet meets the requirements specified in Table 2. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

3.2.2 Placement

The geosynthetic drainage layer shall be unrolled in the direction of maximum slope, keeping the geonet flat against the subgrade to minimize wrinkles and folds. The geosynthetic drainage layer shall not be dragged across textured geomembrane. Adequate ballast (e.g. sandbags) shall be placed to hold the geosynthetic drainage layer in place. No equipment shall be operated on the top surface of the geosynthetic drainage layer. The geosynthetic drainage layer shall be covered with geotextile within 14 days of acceptance.

3.2.3 Seams and Overlaps

3.2.3.1 Geonet Side Seams

Geonet side seams shall be overlapped a minimum of 4 inches or as recommended by the manufacturer, whichever is greater. Side seam fastener spacing shall be a maximum of 5 feet or as recommended by the manufacturer, whichever is greater.

3.2.3.2 Geonet End Seams

Geonet end seams shall be overlapped a minimum of 1 foot or as recommended by the manufacturer, whichever is greater. End seam fastener spacing shall be a maximum of 1 foot or as recommended by the manufacturer, whichever is greater. The overlaps shall be in the direction of flow.

3.2.3.3 Geonet Fasteners

Geonet rolls shall be tied together with plastic fasteners. The fasteners shall be a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.

3.2.3.4 Geotextile Seams

The geotextile component of the geocomposite shall be overlapped in the direction of flow.

3.2.4 Repairs

3.2.4.1 Geonet Damage

Repairs shall be made by placing a patch of the geonet over the damaged area. The patch shall extend a minimum of 2 feet beyond the edge of the damage. Approved fasteners, spaced every 6 inches around the patch, shall be used to hold the patch in place. If more than 25 percent of the roll width is damaged, repair approval must be obtained from the Owner's Representative or else the Contractor shall replace the damaged roll.

3.2.4.2 Geotextile Damage

Damaged geotextile which forms part of a geocomposite drainage layer shall be repaired by placing a patch of geocomposite over the damaged area with a minimum of 18 inches of overlap in all directions. The geocomposite patch shall be held in place with approved fasteners, spaced every 6 inches around the patch.

3.2.5 Acceptance

Geosynthetic drainage layer shall not be covered with geotextile prior to inspection and approval of the geosynthetic drainage layer by the Owner's Representative.

3.3 GEOMEMBRANE

3.3.1 Weather Limitations

Geomembrane shall not be deployed or field-seamed in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. No placement or seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F. In marginal conditions, seaming shall cease unless destructive field seam tests, confirm that seam properties meet the requirements listed in Table 4. Tests shall be conducted in accordance with paragraph Destructive Field Seam Strength Testing.

3.3.2 Surface Preparation

Rocks larger than 1/2 inch in diameter and any other material which could damage the geomembrane shall be removed from the surface to be covered with the geomembrane. Construction equipment tire or track deformations beneath the geomembrane shall not be greater than 1.0 inch in depth. Each day during placement of geomembrane, the Owner's Representative and the Contractor shall inspect the surface on which geomembrane is to be placed. The Contractor shall not place geomembrane until the subgrade has been approved by the Owner's Representative.

3.3.3 Placement

The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. Geomembrane damaged during installation shall be

replaced or repaired, at the Owner's Representative's discretion. Only geomembrane panels that can be anchored and seamed together the same day shall be deployed. Adequate ballast (i.e., sand bags) shall be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. The methods used to deploy and backfill over the geomembrane shall minimize wrinkles and tensile stresses in the geomembrane. The geomembrane shall have adequate slack to prevent the creation of tensile stress. The wrinkle height to width ratio for installed geomembrane shall not exceed 0.5. In addition, geomembrane wrinkles shall not exceed 6 inches in height. Wrinkles that do not meet the above criteria shall be cut out and repaired in accordance with the installer's approved QC procedures.

3.3.4 Field Seaming

3.3.4.1 Geomembrane Trial Seam Testing

Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Trial seam samples shall be collected and tested in accordance with ASTM D 6392. One sample shall be obtained from each trial seam. This sample shall be at least 36 inches long by 12 inches wide with the seam centered lengthwise. Ten random specimens 1 inch wide shall be cut from the sample. Five seam specimens shall be field tested for shear strength and 5 seam specimens shall be field tested for peel adhesion using an approved quantitative tensiometer. To be acceptable, 4 out of 5 replicate test specimens shall meet seam strength requirements specified in Table 4. If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional trial seam fails, the seaming apparatus or seamer shall not be used until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved.

3.3.4.2 Field Seams

Panels shall be seamed in accordance with the geomembrane manufacturer's recommendations. In corners and odd-shaped geometric locations, the number of field seams shall be minimized. Seaming shall extend to the outside edge of panels. Soft subgrades shall be compacted and approved prior to seaming. The seam area shall be free of moisture, dust, dirt, and foreign material at the time of seaming. Fish mouths in seams shall be repaired.

Polyethylene geomembranes shall be seamed by thermal fusion methods where feasible. Extrusion welding shall only be used for patching and seaming in locations where thermal fusion methods are not feasible. Seam overlaps that are to be attached using extrusion welds shall be ground prior to welding. Grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement. Extrusion welding shall begin within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, they shall be ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks shall be no greater than 10 percent of the sheet thickness.

3.3.5 Geomembrane Samples

One QC sample, 18 inches in length, for the entire width of a roll, shall be obtained for every 100,000 square feet of material delivered to the

site. Samples shall not be obtained from the first three feet of the roll. The samples shall be identified by manufacturer's name, product identification, lot and roll/panel number. The date, a unique sample number, and the machine direction shall also be noted. In addition, a 24 inch by 24 inch QA sample shall be collected, labeled, and submitted to the Owner's Representative each time QC samples are collected.

3.3.6 Geomembrane Tests

3.3.6.1 Geomembrane Laboratory Testing

The Contractor shall provide all QC samples to the QC laboratory to determine density, thickness, tensile strength at break, and elongation at break in accordance with the methods specified in Table 3. Samples not meeting the specified requirements shall result in the rejection of applicable rolls/panels. As a minimum, rolls/panels produced immediately prior to and immediately after the failed roll/panel shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls/panels on both sides of the original failing roll/panel pass the failed parameter.

The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

3.3.6.2 Non-Destructive Field Seam Continuity Testing

Field seams shall be non-destructively tested for continuity over their full length in accordance with the installer's approved QC manual. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Any seams which fail shall be documented and repaired in accordance with the installer's approved QC manual.

3.3.6.3 Destructive Field Seam Strength Testing

A minimum of one destructive test sample per 500 feet of field seam shall be obtained at locations specified by the Owner's Representative. Sample locations shall not be identified prior to seaming. Samples shall be a minimum of 12 inches wide by 42 inches long with the seam centered lengthwise. Each sample shall be cut into 3 equal pieces, with one piece retained by the installer, one piece given to the QC laboratory, and the remaining piece given to the Owner's Representative for QA testing and/or permanent record. Each sample shall be numbered and cross referenced to a field log which identifies: (1) panel number; (2) seam number; (3) date and time cut; (4) ambient temperature within 6 inches above the geomembrane; (5) seaming unit designation; (6) name of seamer; and (7) seaming apparatus temperature and pressures (where applicable). Ten 1 inch wide replicate specimens shall be cut from the installer's sample. Five specimens shall be tested for shear strength and 5 for peel adhesion using an approved field quantitative tensiometer. To be acceptable, 4 out of 5 replicate test specimens shall meet the seam strength requirements specified in Table 4. If the field tests pass, 5 specimens shall be tested at the QC laboratory for shear strength and 5 for peel adhesion in accordance with the QC laboratory's approved procedures. To be acceptable, 4 out of 5 replicate test specimens shall meet the seam strength requirements specified in Table 4. If the field or laboratory tests fail, the seam shall be repaired in accordance with paragraph Destructive Seam Test Repairs. Holes for destructive seam samples shall be repaired the same day they are cut.

3.3.7 Defects and Repairs

3.3.7.1 Destructive Seam Test Repairs

Seams that fail destructive seam testing may be overlaid with a strip of new material and seamed (cap stripped). Alternatively, the seaming path shall be retraced to an intermediate location a minimum of 10 feet on each side of the failed seam location. At each location a 12 by 18 inch minimum size seam sample shall be taken for 2 additional shear strength and 2 additional peel adhesion tests using an approved quantitative field tensiometer. If these tests pass, then the remaining seam sample portion shall be sent to the QC laboratory for 5 shear strength and 5 peel adhesion tests in accordance with the QC laboratory's approved procedures. To be acceptable, 4 out of 5 replicate test specimens must meet specified seam strength requirements. If these laboratory tests pass, then the seam shall be cap stripped or repaired using other approved methods between that location and the original failed location. If field or laboratory tests fail, the process shall be repeated. After repairs are completed, the repaired seam shall be non-destructively tested in accordance with paragraph Non-Destructive Field Seam Continuity Testing.

3.3.7.2 Patches

Tears, holes, blisters and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming as determined by the QC inspector. Repairs shall be non-destructively tested. The Owner's Representative or the QC inspector may also elect to perform destructive seam tests on suspect areas.

3.3.8 Visual Inspection and Evaluation

Immediately prior to covering, the geomembrane, seams, and non-seam areas shall be visually inspected by the QC inspector and Owner's Representative for defects, holes, or damage due to weather conditions or construction activities. At the Owner's Representative's or the QC inspector's discretion, the surface of the geomembrane shall be brushed, blown, or washed by the installer if the amount of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Each suspect location shall be non-destructively tested in accordance with paragraph Non-Destructive Field Seam Continuity Testing. Each location that fails non-destructive testing shall be repaired in accordance with paragraph Patches and non-destructively retested.

3.3.9 Protection and Backfilling

The deployed and seamed geomembrane shall be covered with the specified material within 14 calendar days of acceptance. Wrinkles in the geomembrane shall be prevented from folding over during placement of cover materials.

3.3.10 Geomembrane As-Built Drawings

Final as-built drawings of the geomembrane installation shall be prepared. These drawings shall include panel numbers, seam numbers, location of repairs, destructive seam samples, and penetrations.

-- End of Section --

SECTION 31 10 00

CLEARING FOR CIVIL WORKS
04/06

PART 1 GENERAL

1.1 AUTHORIZATION FOR CLEARING

All ground areas requiring clearing for site access shall be approved by the Owner's Representative prior to the commencement of clearing activities.

All construction roads for access to the work area shall be approved by the Owner's Representative, as to location and alignment, prior to construction.

1.1.1 EXISTING CONDITIONS

PART 2 PRODUCTS

All logs, cordwood, wood chips, mulch, other marketable timber products, and all waste products shall become the property of the Contractor.

PART 3 EXECUTION

3.1 REMOVAL OF FENCES

Fence sections along the toe of the CMSD landfill slope which have been dislocated by the sliding soil mass shall be temporarily removed.

Fence sections may be removed to permit or enhance site access with the approval of Ormet's Representative.

All fence materials removed, if reusable, shall be stored in a location and manner to prevent damage. All fences removed shall be replaced at the end of construction.

3.2 CLEARING BRUSH AND TREES

The Contractor shall cut brush and trees only in areas and to the extent authorized by the Owner's Representative.

A tree chipper may be used at the option of the Contractor in all clearing operations.

All material cleared shall be completely removed by transporting from the property. In no case shall cleared material be thrown into or left in the river. No burning of brush or trees shall be allowed on site.

3.3 REMOVAL OF TEMPORARY SLOPE PROTECTION

The main failure area of the CNMSD landfill slope is protected against rainwater infiltration by temporary plastic sheeting. The Contractor shall remove the temporary plastic sheeting as slope reconstruction progresses.

The temporary plastic sheeting shall remain in place until the day the contractor is ready to reconstruct the multilayer cap. The temporary plastic sheeting must remain in place during periods of precipitation.

The Contractor shall replace the temporary plastic sheeting at the end of each working day over all slope areas with less than two accepted lifts of VSL soil in place. The temporary plastic sheeting shall be anchored in place with sandbags or rocks to prevent uplift from the wind. The soil beneath the lower end of the temporary plastic sheeting shall be contoured to provide an outlet for any water which may accumulate on the temporary plastic sheeting.

The Contactor shall dispose of the temporary plastic sheeting when it is no longer required for slope protection.

3.4 EROSION PROTECTION

All ground areas which are disturbed by clearing operations and which would become subject to erosion will be protected from erosion during the Project execution.

-- End of Section --

SECTION 31 25 13

EROSION AND SEDIMENTATION CONTROLS

10/06

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

The work consists of furnishing and installing soil surface erosion control materials to prevent the pollution of air, water, and land, including fine grading, blanketing, stapling, mulching, vegetative measures, structural measures, or other miscellaneous related work, within project limits and in areas outside the project limits where the soil surface is disturbed from work under this contract at the designated locations. This work includes all necessary materials, labor, supervision and equipment for installation maintenance of a complete system, and removal of temporary system components at the completion of the Project.

PART 2 PRODUCTS

The Contractor shall select any and all products and materials for erosion control. Products may include, but are not necesssarily limited to, soil binders, mulch, straw, hay, wood cellulose fiber, paper fiber, shredded bark, wood by-products, mulch control netting, hydraulic mulch and tackifier, geotextile fabrics, erosion control blankets, silt fencing, or aggregate.

PART 3 EXECUTION

The Contractor shall be responsible for selecting, installing, and maintaining erosion and sediment control measures. Erosion control measure locations may be adjusted to meet field conditions. All erosion damage in reconstructed CMSD landfill cap areas, elsewhere within Project limits, or areas outside the project limits shall be repaired at the Contractor's expense to the satisfaction of the Owner's Representative.

-- End of Section --

SECTION 32 00 00

EXTERIOR IMPROVEMENTS
10/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

SD-07 Certificates

Seed Certification

PART 2 PRODUCTS

2.1 SEED

2.1.1 Grass Seed

Provide seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected.

Furnish grass seed from a grass seed dealer or grower whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture or from the approved list of grass seed dealers or growers on file with Department. Furnish the kind and type of grass seed required that meets the minimum percentage germination rates specified below.

TABLE 1
Germination Rates

Species	Minimum Percent
Kentucky Bluegrass	80
Fine Fescue	85
Perennial Ryegrass	85
Annual Ryegrass	85
Tall Fescue	85

TABLE 1
Germination Rates

Species	Minimum Percent
Creeping Red Fescue	85

Mark the test date on seed bags. Furnish seeds as separate species and cultivars, packaged together or bagged separately, and properly labeled, tagged, or marked. Sow seeds within 9 months of the testing date.

Submit a written Seed Certification for the seed. Include the following with the description:

A. Name and location of the seed supplier.
B. Origin and date of harvest of each kind of seed.
C. A statement of the purity and germination of each seed.
D. Testing date for each seed.

2.1.2 Crown Vetch

Inoculate or treat all crown vetch seeds with the proper amount of pure nitrogen-fixing bacteria and mix with sufficient water to thoroughly wet the seed. The bacteria selected will be for maximum vitality and shall not be more than one-year old. All culture records will be provided with the leguminous seeds.

If sown hydraulically, use 4 times the inoculant rate specified by the inoculant manufacturer. If pre-inoculated seed is used then use 3 times the inoculant rate specified by the inoculant manufacturer. Immediately before seeding, add inoculant and sticking agent directly into the slurry, and thoroughly mix the slurry. Sow seed as soon as possible after inoculation. If left standing for more than 24 hours, reinoculate seed before sowing. Mix all seed on the project.

Submit a written Seed Certification for the seed. Include the following with the description:

A. Name and location of the seed supplier.
B. Origin and date of harvest of each kind of seed.
C. A statement of the purity and germination of each seed.
D. Testing date for each seed.

2.2 SOIL CONDITIONERS, MULCH, AND WATER

The Contractor shall furnish and apply soil conditioners, mulch, and water as necessary to improve the germination and establishment of the vegetative cover of grass and crown vetch. The types, application rates, and application methods are the responsibility of the Contractor. Areas which fail to develop vegetation shall be reseeded at the Contractor's sole expense.

PART 3 EXECUTION

3.1 SEEDING

3.1.1 Extent of Work

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations and designated for seeding by the Owner's Representative.

3.1.2 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling. Store in cool, dry locations away from contaminants.

3.1.3 Seed Application Seasons and Conditions

Do not seed when ground is muddy, frozen, snow covered, or in an unsatisfactory condition for seeding. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.1.4 Seed Application Method

Seeding method shall be broadcasted and drop seeding, drill seeding, or hydroseeding.

3.1.5 Minimum Coverage and Reseeding

The Owner's Representative will inspect all seeded areas no earlier than 6 months and no later than 12 months after final seeding. For any area identified without a uniform density of at least 70 percent grass cover or established crown vetch, the Contractor will reseed at no cost to Ormet.

3.1.6 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

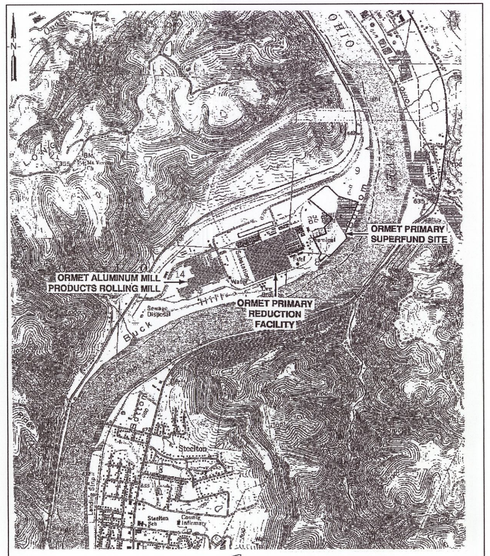
3.2 SITE RESTORATION AND DEMOBILIZATION

The Contractor shall remove all temporary construction signs and fencing, remove all temporary erosion control measures, remove any temporary facilities or structures, remove all equipment, reconstruct permanent fencing, restore disturbed areas, and perform final site cleanup.

The Contractor shall reinstall any portions of the chain link fence along the toe of the CMSD landfill slope removed during the Project. If serviceable, the original fencing and poles may be reinstalled.

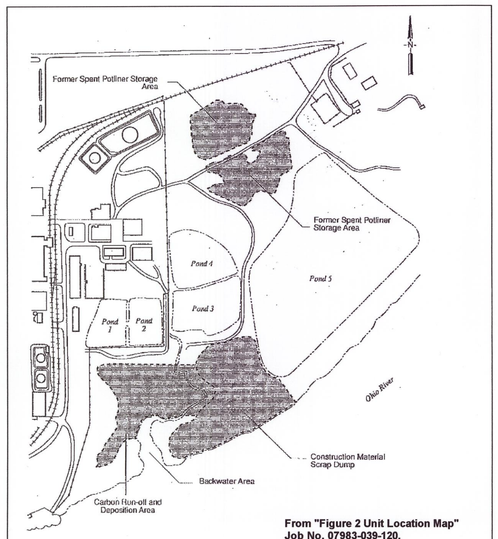
The Contractor shall regrade and reseed any areas disturbed by movement of construction equipment or other construction activities to the satisfacton of the Owner's Representative.

-- End of Section --



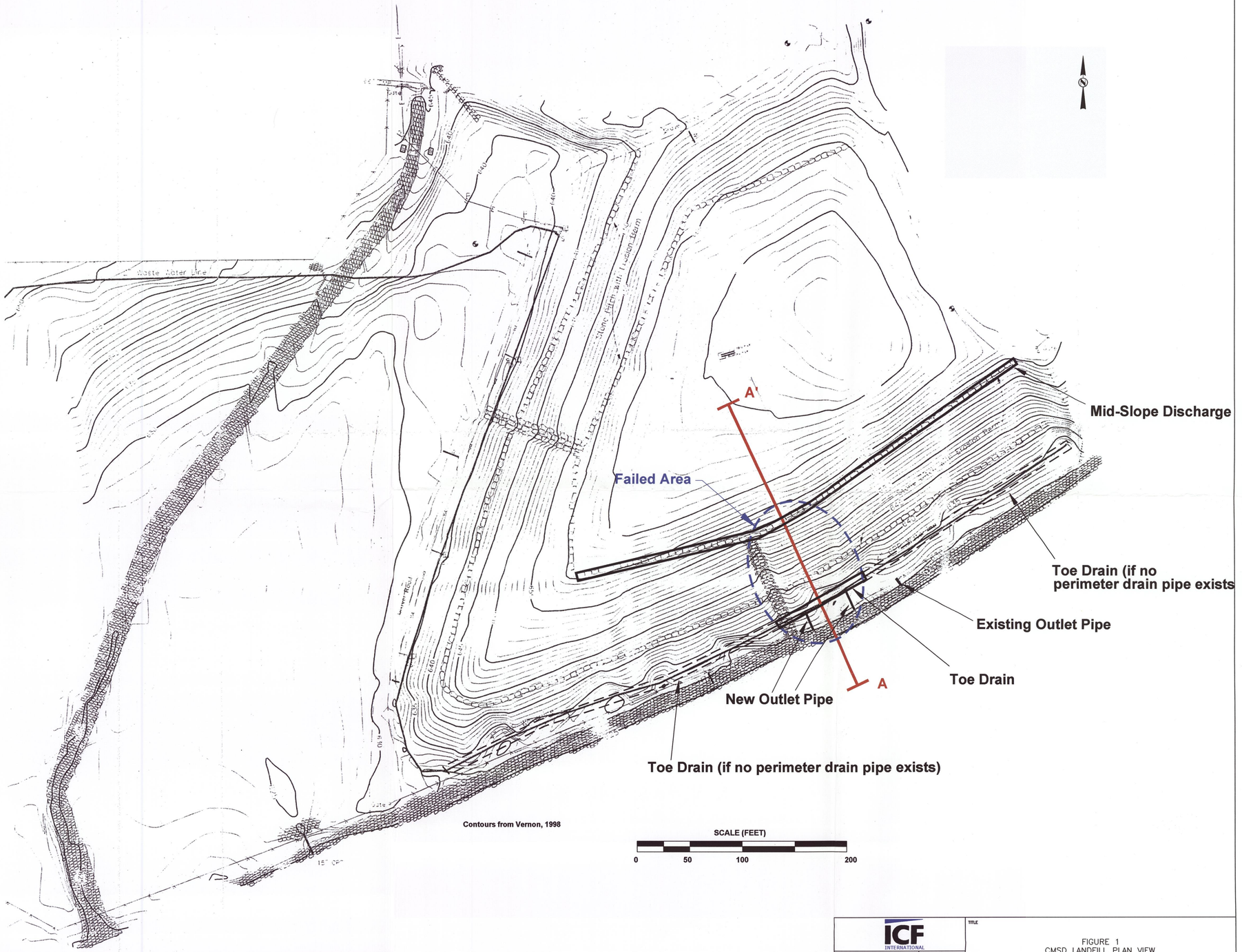
BASE MAP SOURCE: USGS 7 1/2 minute topographic quadrangle map New Martinsville, West Virginia-Ohio 1960, photorevised 1972 and 1976.

From "Figure 1 Site Vicinity Map" Job No. 07983-039-120, Dames & Moore



From "Figure 2 Unit Location Map" Job No. 07983-039-120, Dames & Moore

NOT TO SCALE



ICF INTERNATIONAL		TITLE: FIGURE 1 CMSD LANDFILL PLAN VIEW	
APPROVALS	DATE		
DRAWN		PREPARED FOR: ORMET	SCALE: 1 IN. = 50 FT.
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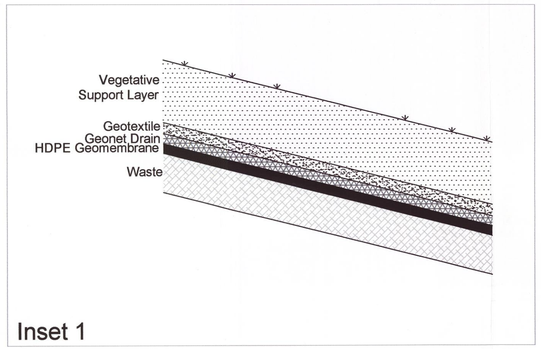
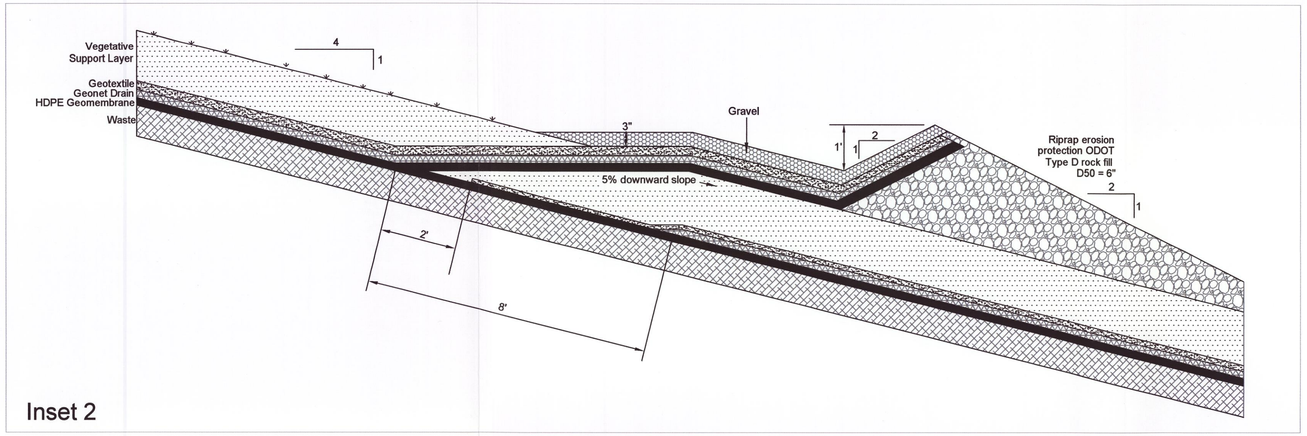
QA/CONTROL		DATE: MARCH 2007	DWG. NO.: FIGURE 1
TECH REVIEW		SOURCE: VERNON, DAMES & MOORE	SHEET 1 OF 1
PROJ MNGR			



Inset 1



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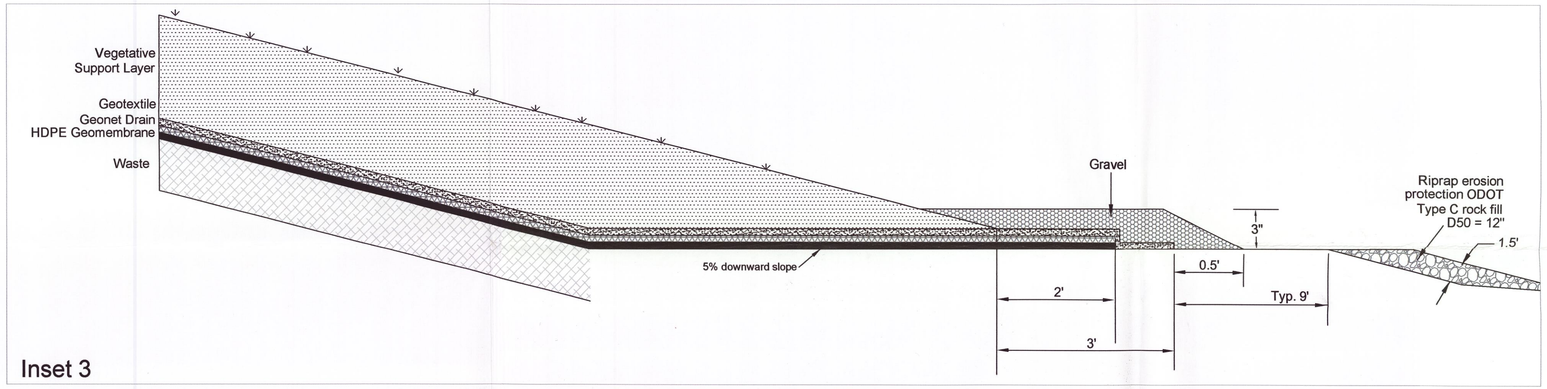

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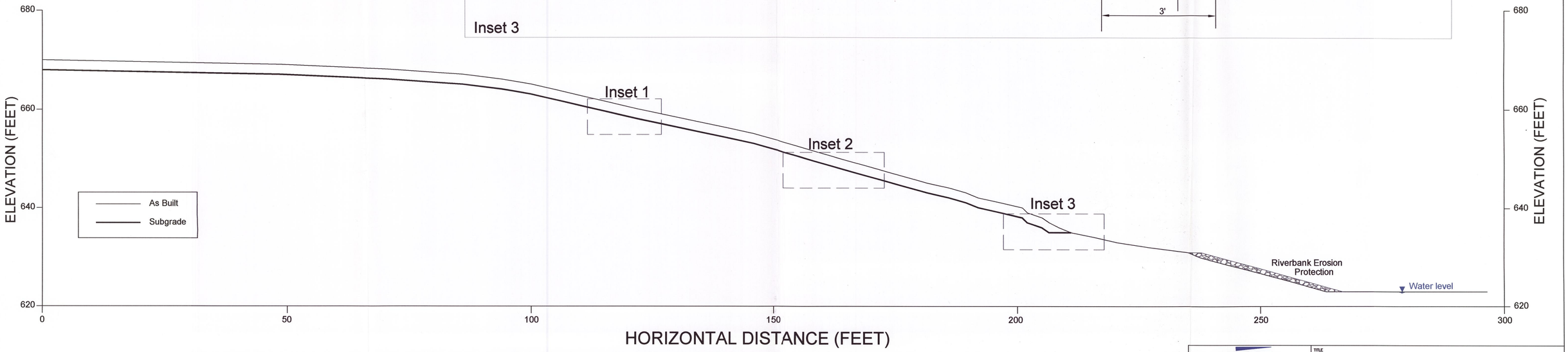

ICF INTERNATIONAL		TITLE: FIGURE 2 CROSS SECTIONS	
APPROVALS	DATE		
DRAWN		PREPARED FOR: ORNET	SCALE: AS SHOWN
CHECKED			
QA/CONTROL		DATE: MARCH 2007	DWG. NO.: FIGURE2
TECH REVIEW		SOURCE: ICF INTERNATIONAL	SHEET 1 OF 1
PROJ MNGR			